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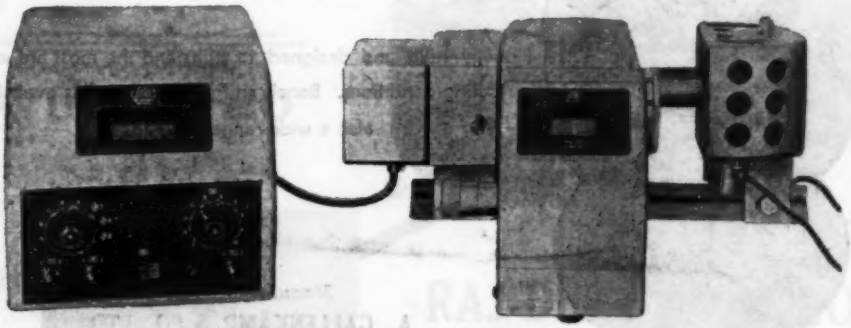

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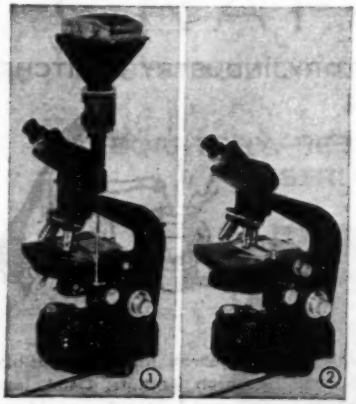

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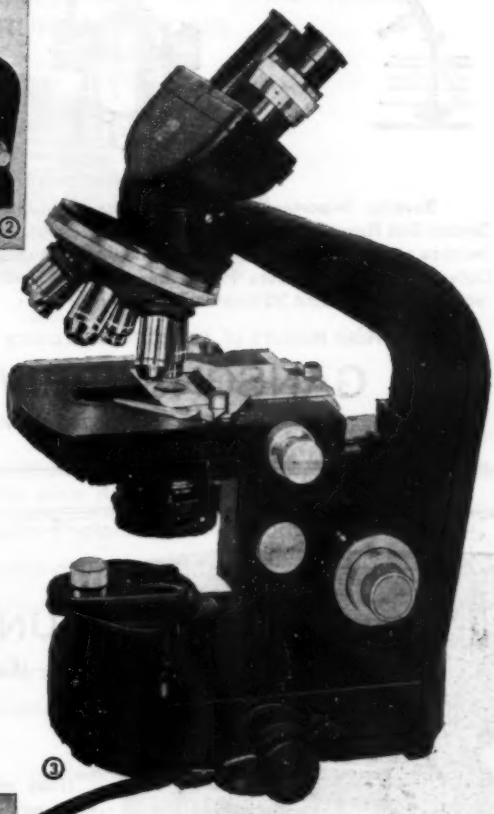

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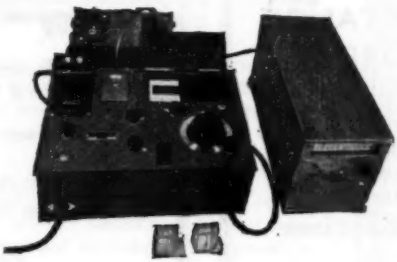

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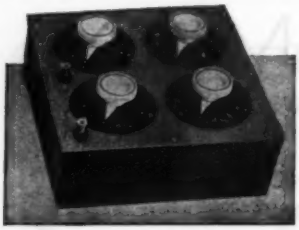

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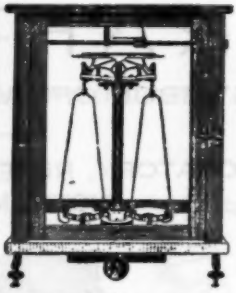

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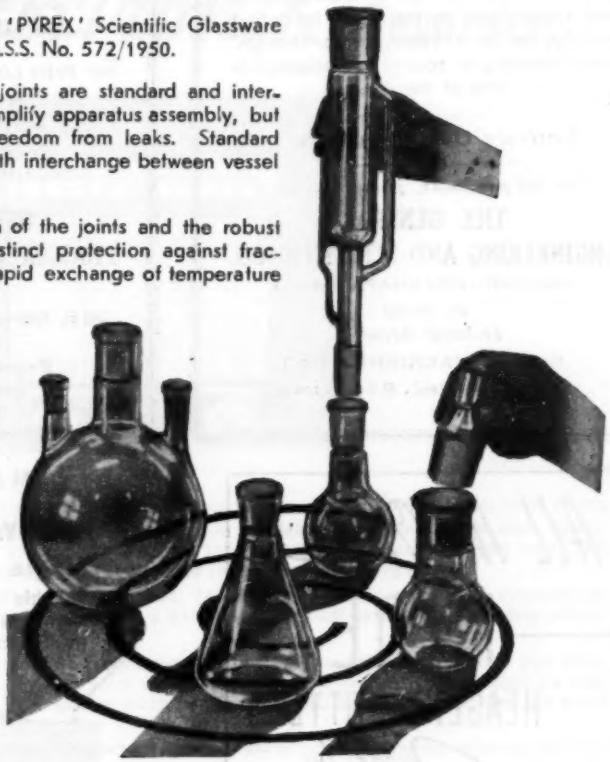

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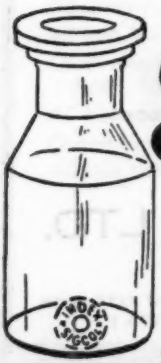

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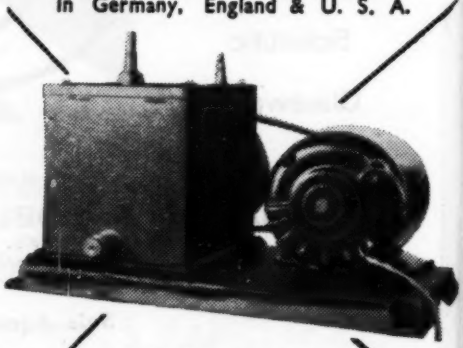

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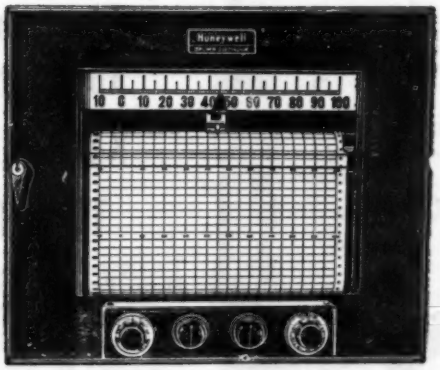

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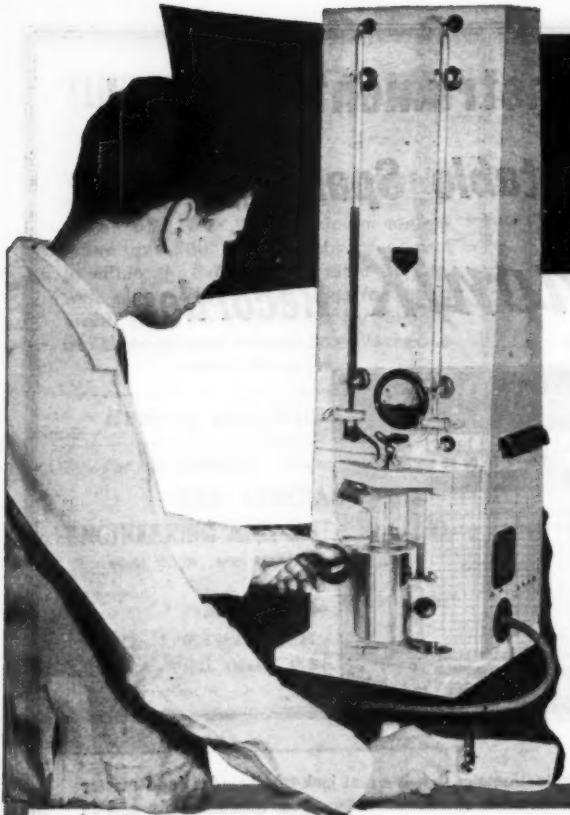

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THE SPECIFIC HEATS OF CRYSTALLINE SOLIDS: PART II

Sir C. V. RAMAN

THE theory of the specific heats of crystals expounded in the first part of this review is similar in its approach to that originally proposed by Einstein in the year 1907, but it fills up the lacunæ left in that theory and succeeds in connecting the thermal energy of crystals with their spectroscopic behaviour, as also in explaining the facts of observation in both of these fields. It is hoped on some later occasion to set out the results following from the theory in greater detail and to illustrate them by specific examples. The present review will conclude with some comments on the theory of the specific heats of crystals put forward by Debye in the year 1912 and the closely analogous theory published by Born and Karman at about the same time. A whole generation of physicists and chemists has been persuaded to believe that these theories embody valid physico-mathematical thought and that they satisfactorily account for the facts of observation. These are circumstances which justify the inclusion in the present review of some critical remarks on those theories.

2. The Fundamentals of Specific Heat Theory

We may usefully commence our examination by recalling the ideas embodied in Einstein's paper of 1907 in the form of three distinct propositions.

I. A crystal is an assembly in thermodynamic equilibrium of an immense number of individual oscillators which are divisible into sets, each set consisting of a great number of oscillators characterised by a common frequency of vibration.

II. The total number of oscillators of all sorts is equal to thrice the number of atoms comprised in the crystal.

III. The vibrational energy of each individual oscillator is quantised and its average value taken over its different possible energy states may be determined by the aid of Boltzmann's principle.

The first of these propositions finds its justification in the known physical features of crystal architecture. The second proposition follows as a logical deduction from the first taken in conjunction with the results of classical mechanics. The third proposition is a logical consequence of the principles of thermodynamics and the quantum theory when applied to the circumstances stated in the first proposition. In the earlier part of this review, it has already been shown how these propositions enable us to deduce both the thermal and the spectroscopic behaviour of crystals.

3. The Theories of Debye and Born

The basic idea underlying these other theories is that the thermal energy of a crystal may be evaluated in the same manner as the energy density of thermal radiation within a perfectly reflecting enclosure, in other words, by summing up the kinetic and potential energies of sets of wave-trains which are assumed to fill the volume of the solid and form stationary wave-patterns in its interior. J. H. Jeans who was the original proposer of this idea indicated in his paper of 1909 a way of escape from the more obvious difficulties which arise when it is sought to make use of it. Debye and Born who derived their inspiration from Jeans naturally also took over from his paper the special assumptions needed to put his ideas into quantitative form. These special assumptions figure prominently in both of the theories and are indeed their most characteristic feature.

The stationary wave-patterns considered by Debye were those contemplated in the classical theory of elasticity for a solid of finite volume. An enumeration on the basis of that theory shows the total number of modes of vibration to increase — without any upper limit — proportionately to the cube of the frequency up to which the enumeration is carried. To enable the enumeration thus made to form the basis of specific heat theory, Debye assumed that the enumeration is valid only up to a certain upper limit of frequency and that no modes of vibration with higher frequencies exist; the upper limiting frequency was so chosen that the number of wave-patterns is equal in number to thrice the number of atoms comprised in the crystal.

The waves considered by Born are of a more general type than those considered in the Debye theory. Whereas Debye limited himself to the consideration of crystals of comparatively simple type, *viz.*, those containing a single species of atom and belonging to the cubic system, the theory of Born accepts no such limitation and indeed claims to be applicable to all crystals. The special assumption which figures in the Born theory is the well-known "cyclic postulate" which selects the permitted wave-lengths of the stationary wave-patterns filling the solid in such manner that the total number of wave-patterns is equal to thrice the number of atoms comprised in the crystal.

The questions which arise and which need to be considered are the following: Are the approaches to specific heat theory briefly summarized above logically sustainable? Are the ideas on which they are based and the conclusions to which they lead compatible with the fundamental principles of classical mechanics, thermodynamics and the quantum theory? We shall consider these questions and presently find that the answer is in each case definitely in the negative.

4. The Logical Fallacy

A simple calculation shows that the frequencies of vibration which determine the variation of the specific heats of crystals with temperature lie in the infra-red region of the spectrum. It follows that the oscillators which are the carriers of the thermal energy are the ultimate structural elements in the crystal. This is further confirmed by the fact that when the atoms are firmly bound together in the structural elements of the crystal, as is the case for example with diamond, the specific heats are low and the vibrational frequencies estimated from them are high; the latter inference receives direct support from spectroscopic studies. It follows from these remarks that the approach to the specific heat problem made in the theories of Debye and Born is totally misconceived. These authors concern themselves with an entirely different and irrelevant subject, namely, the vibrations of a macroscopic solid and proceed to determine and enumerate them, treating it as a boundary-value problem in wave-propagation. It is easily shown that the results thus obtained are wholly unrelated to the specific heat problem. We have only to recall that wave-motion is a kinematic concept. Hence the stationary wave-patterns inside an enclosure can be described in purely geometric terms without any reference to the question whether the material traversed by the waves does or does not possess a discrete structure. In other words, there is no nexus or connection between the

stationary wave-patterns assumed to exist in the medium and the discrete structure, if any, which it possesses. It is not surprising in these circumstances that Debye and Born are obliged to introduce postulates into their theories which assume the existence of such a relationship. We have only to remark that such postulates or assumptions savour of sophistry and that theories embodying them can lay no claim to logical validity.

5. Falsity of the Dynamical Consequences

The theories of Debye and Born are attempts to carry over the ideas and methods of macroscopic physics into the fields of atomic dynamics, thermodynamics and quantum theory where they are inappropriate and indeed wholly out of place. The procedures they adopt naturally lead to consequences which are irreconcilable with the basic principles of these disciplines and the results following from them.

Considering the matter first from the standpoint of atomic dynamics, it is clear that we are not concerned here either with wave-propagation or with any boundary value problem. Specific heat theory rests on the determination and enumeration of the normal modes of vibration of the ultimate particles of the material, in other words, of the atoms present in the structure of the crystal. Since the range of the interatomic forces is limited and small compared with the dimensions of any crystal of macroscopic size, these normal modes are determinable from the structure of the crystal without any reference to the size of the crystal or to the conditions at its external boundary. This also becomes evident when we compare the frequency of the atomic oscillations with the frequency of the elastic oscillations of a macroscopic crystal. The former is very great in comparison with the latter even for a crystal of colloidal dimensions. Hence the oscillations of the atoms in the interior of a crystal repeat themselves many thousands of times, thereby defining their frequency with all necessary precision, before any disturbance originating in the interior of the crystal could travel out to reach its surface and return after reflection to the place of its origin. Hence, whether the boundary is there or not makes no difference to the modes and frequencies of atomic vibration.

The fallacy of identifying the atomic vibrations with stationary wave-patterns is obvious even in such simple cases as those considered by Debye. The vast majority of the stationary wave-patterns assumed in his theory to be the carriers of the thermal energy of the crystal have wave-lengths of the same order of magnitude as its lattice spacings. These are precisely the circumstances in which it is not permissible to identify the dynamical behaviour of a discrete structure with that of a medium of uniform density. The consequence of such identification is to endow the crystal with an immense number of modes of vibration with frequencies all different from each other throughout the range under consideration and thus to present a false picture of the spectroscopic behaviour of the crystal.

Though Born's theory nominally takes account of the discrete lattice structure of crystals, his "postulate of the cyclic lattice" is equivalent to assuming that the normal modes of vibration of the atoms are similar to the oscillations of the volume elements in a continuous solid having the same shape as the unit cell of the crystal but of greatly enlarged size. The stationary vibrations permitted by the postulate accordingly appear in immense numbers with wave-lengths and frequencies all different from each other and with their modes wholly unrelated to the structure of the crystal. It is important to remark in this connection that Born does not restrict himself to simple lattice structures but also claims his theory to be valid for all crystals. Any one who appreciates the nature of the results following from Born's lattice theory will realize that the ideology behind his dynamics is completely false. In effect, Born endows the atoms in a crystal with a vast number of modes and frequencies of vibration which are wholly unrelated to its internal architecture and which have a continuous spectrum of frequencies, a result which is in flagrant contradiction with the facts of observation revealed by spectroscopic investigations.

6. Conflict with Thermodynamics

A stationary wave-pattern is a mode of vibration in which all the volume elements of the medium oscillate with the same frequency and in the same or opposite phases and with relative amplitudes which remain invariant with time. Vibrations of this type are characteristic of a macroscopic solid and can be considered as its normal modes of vibration and determined by the methods of the classical theory of elasticity. Such vibrations can also be set up and maintained in an elastic solid artificially, as for example, by the use of a piezo-electric oscillator attached to it.

The identification of the thermal agitation in crystals with stationary wave-patterns of the nature described above which is postulated in

the theories of Debye and Born is however clearly irreconcilable with the statistical concept of the nature of thermal energy in material bodies. Thermal agitation is envisaged in Boltzmann's entropy-probability principle as a chaotic and fluctuating disturbance varying in its character and intensity from instant to instant and from place to place within the material. Atomic groups of similar nature which are located in parts of the crystal not contiguous to each other may indeed vibrate with the same frequency. But there can be nothing in the nature of definite relationships either in their amplitudes or in their phases of vibration persisting in time.

The issue can also be put a little differently. A crystal is an assembly of an immense number of individual atoms which are capable of moving from their positions of equilibrium. Hence the state of the system can only be described in terms of the values of a very large number of independent variables. The interactions between neighbouring atoms would naturally influence their relative movements and determine their modes and frequencies of vibration. But we cannot in any circumstances regard the entire assembly as a single unit in the thermodynamic sense or postulate constancy of amplitude or coherence of phase in the atomic vibrations over its entire volume. A description of the thermal agitation in precisely defined terms is possible only for domains of space and periods of time which are small in comparison with macroscopic standards. In other words, the entire ideology behind the theories of Debye and Born is incompatible with the fundamental notions of the nature of thermal energy which lie at the base of the science of thermodynamics.

7. Misinterpretation of the Quantum Theory

As has been shown above, the theory of specific heats can be placed on a logically sustainable basis only if we recognize that the oscillators which are the carriers of the thermal energy are the structural elements in the crystal. We then obtain a picture of the thermal agitation in the solid which is consistent with the general principles of dynamics and of thermodynamics. Necessarily, therefore, it is these same oscillators whose vibrational energies must be assumed to be quantised. Since, further, these oscillators are present in large numbers distributed over the volume of the crystal, we have a logical justification for the use of Boltzmann's principle in conjunction with the quantum hypothesis for the evaluation of the average energy of the oscillators of any particular frequency and therefrom also the evaluation of the heat capacity of the entire crystal.

To the fallacies which vitiate the Debye and Born theories we have therefore to add one more, *viz.*, that they give a fantastic and altogether meaningless interpretation to the postulates of the quantum theory. They proceed to quantise the energy of the normal modes of vibration of a macroscopic crystal; in doing this, they ignore the fact that the theory of quanta possesses a meaning and significance only in relation to the behaviour of the physical entities which the language of determinism characteristic of macroscopic physics cannot successfully describe. For example, we can speak meaningfully of quantising the energies of rotation or vibration of a molecule of benzene; but it is patently absurd to quantise the vibrations of a tuning fork or the rotations of a flywheel.

DISCOVERY OF ELEMENT 102

ELEMENT 102, as yet unnamed, has been discovered in the course of a joint research project by scientists from Sweden, Great Britain and U.S.A. In the experiments performed to make this new element, curium-244 deposited upon a thin foil was exposed to a stream of accelerated carbon ions generated by the 225-cm. cyclotron at the Nobel Institute, Stockholm. The carbon ions included both carbon 13 and carbon 12 particles. Absorption of carbon 13 particles in the curium led to the formation of element 102. The element 102 formed was collected on a separate foil placed near the target foil, along with other atoms produced and ejected by the interaction of the beam of particles and the target.

Element 102 was identified among the products on the capture foil by radiochemical methods; the isotope identified had a half-life of about 10 min. and emitted alpha-particles with an energy of 8·5 MeV. The isotope probably has a mass of 253 but this has not yet been established with certainty.

THIRTY-TWO YEARS AGO

WE reproduce on this page a picture taken at the banquet given in Leningrad on the occasion of the Bicentenary of the U.S.S.R. Academy of Sciences celebrated in September 1925. Three delegates from India attended the celebrations. Professor C. V. Raman represented Science. The two others were orientalists, *viz.*, Messrs. H. Mody and Braganza Kun. The picture shows the first-named in the foreground facing the camera. Seated near him on the opposite side of the table and at the extreme right of the picture appears Professor Joffe, the well-known Soviet physicist, an article by whom was published in the June issue of *Current Science*.

Looking back over the years, no one can fail to be impressed by the amazing development of science and technology in the Soviet Union. The principal factor has been, of course, the very great attention paid to scientific and technological education, research and development by the U.S.S.R. Government. Many of these activities are carried on by and through the U.S.S.R. Academy of Sciences which is a large and powerful organisation.

The same issue of *Soviet Land* contains an interesting account of the procedure adopted in the Soviet Union for the conferment of scientific degrees. This is calculated, on the one hand, to encourage originality and, on the other, to prevent access to science of persons who have no talent or ability to do creative scientific work.

A recent article in the magazine *Soviet Land* from which the picture has been reproduced recalls that this was the first visit of Indian scholars to the Soviet Union and that it made a special contribution to the development of Indo-Soviet cultural co-operation. During their sojourn the Indian delegates were the centre of public attention. Their portraits appeared in the Moscow and Leningrad newspapers and numerous interviews with them were published.

WHY IS IT DARK AT NIGHT?

IN a recent article appearing in *The New Scientist* (Vol. 2, No. 30), Professor Hermann Bondi remarks that the attempt to answer this apparently simple question leads us on into the profoundest issues in cosmology.

Prof. Bondi begins by summarising the arguments relating to this question put forward by the German astronomer Olbers about 130 years ago. The arguments are based upon simple and apparently reasonable assumptions regarding the distribution of stars in space and their inherent brightness and on the familiar photometric formula of the inverse square of the distance. These assumptions lead to startling conclusions. After allowing for the obscuration of the light of the stars by those in front of them, a calculation of the intensity of the total light of the stars reaching us shows that it should be some 40,000 times as strong as direct sunlight. This, of course, is in total disagreement with what we actually observe.

Prof. Bondi discusses the explanation of this paradox, considering in turn each of the primary assumptions on which the calculations are based. As light travels at a finite speed, we are now seeing the distant regions as they were a long time ago. Olbers assumed that this does not matter, in other words, that the distant parts of the universe were in the same state as our immediate astronomical neighbourhood is at present. Olbers further assumed that in these distant regions the stars are scattered at the same average density and have the same average brightness. The absence of any important systematic movements amongst the stars was also implicitly assumed. There are two alternative possible ways of escape from the paradox presented by the actually observed weakness of starlight. One of them is to assume that the universe is not an unchanging entity but is actually evolving, and that a sufficiently long time ago the stars did not shine. This would resolve the paradox. The other is to hold on to the idea of an unchanging universe but to take account of the expansion of the universe indicated by the general theory of relativity and the various consequences following therefrom. Prof. Bondi expresses the opinion that the latter approach does not completely resolve the difficulties but that it is necessary also to assume that matter is being continuously created in the universe.

In concluding the article, Prof. Bondi remarks that the final decision between the two alternative approaches must rest upon new observational data.

INTERNATIONAL CONFERENCE ON RADIO ISOTOPES IN SCIENTIFIC RESEARCH

IT is well known that there has been a phenomenal increase in the applications of radio isotopes to the study of physico-chemical processes encountered in industry, medicine, and practically all fields of research. The characteristic radiations that enable the detection of minute traces of these substances, and the insensitivity of physico-chemical reactions to isotopic composition, contribute to the universality and power of this technique. The International Conference on Radio Isotopes in Scientific Research to be held in Paris from 9th to 20th September 1957, organised by the UNESCO under the Chairmanship of Sir John Cockroft, undertakes a comprehensive review of this subject, and the abstracts of the 220 papers to be presented at this discussion cover a remarkably wide range of topics.

About a dozen papers deal with the progress in instrumentation, especially in scintillation counter methods for the assay of β and γ activities, and in the methods for radiation dosimetry. There are about 10 papers regarding the preparation of artificial sources by pile irradiation, extraction from fission products, and the use of the mass spectrometer as an electromagnetic isotope separator. (It may be mentioned the latter was the outcome of the "Calutrons" used for U^{235} separation in the early stages of the A-bomb project!)

The use of radiotracer methods to the study of diffusion in metals and alloys is fast gaining in importance, and several papers are concerned with studies on mobility of atoms and grain boundary diffusion and Kirkendall effect.

A large number of publications deal with the applications to the study of a variety of chemical reactions, as ion exchange, precipitation, surface reactions, catalysis, etc. There is a very vast amount of work that concerns the study of the manifold reactions that take place in human and animal metabolism, while an equally large proportion of the papers is constituted by studies pertaining to plant metabolism.

A heartening feature is the very large number of Russian publications; we earnestly hope that contacts on a scientific and cultural plane would bring about the mutual understanding that the world so much longs for.

NEW STAGE IN AUTOMATION OF INDUSTRY: ON THE POSSIBILITIES OF CALCULATING TECHNIQUE

PROF. D. PANOV

UNTIL recently, control of machine tools and assemblies was achieved principally by employing devices capable of automatizing a particular process performed by a particular machine tool, such as the turning of some axle. But if it was required that the same machine tool perform other work, that is, for instance, turn parts of different size and shape than that axle, then the control device for the machine tool had to be remodelled. In view of this, numerical systems of control have begun to be employed where there is a need for automatizing control of a machine tool, that is performing diverse functions. They have come to be known as such because they are built up on the same principles as the modern numerical calculating machines.

Modern numerical systems are very flexible, precise and quick-acting. With their help, a machine tool or installation can be made to perform automatically a complicated program in which all operations have been consecutively indicated beforehand. Such a program can be easily altered according to need. These systems have an added advantage in that they can be effectively used for remote control of machines.

At present, automation of machine tools is following these two main trends that have just been indicated. The first consists in building up automatic production lines comprised of highly specialized machine tools with a rigid system of control. Such lines are intended for turning out a definite type of goods whose size and shape are not to be altered. It is clear that such a method of automation *freezes* the goods as it were. This method is quite applicable to goods standardized for a more or less protracted period, such as ball bearings. But in branches of industry where new models are constantly being introduced, as, say, the aviation industry, it is of little use. Here another method of automation is more preferable, one which ensures great flexibility. It consists in building up an automatic production line comprised of general purpose machine tools, controlled by devices that can easily alter the character of the work, the tools perform. And it is here that the numerical program system of control finds application. If such a "universal" automatic production line is furnished, besides, with program controlled conveying contraptions, it is possible to switch over very quickly to the output of a new model by simply changing the program in the control device.

A case in point is the copy milling machine being created by Soviet industry. Control here will be effected by a numerical device through which runs a tape carrying the program. The device will "read" the commands recorded on the tape and transmit them to motors operating the working parts of the machine tool, a given degree at given moments.

Under such a system of control, a high level of tooling precision is attained and the need for sizing, setting up master forms, etc., is done away with. Re-adjustment of such a machine tool becomes very easy, reduced to the simple replacement of one reel of tape by another. The switch-over to such automatic control is accompanied by a two- to five-fold, and sometimes even greater, cut in production time.

Numerical control systems may be successfully employed in other technological processes as well.

This type of automation also has many other advantages. Suppose that the output of some complicated product which has been mastered at one enterprise has to be organized at another. If at this other enterprise there is an identical universal automatic production line, controlled by a numerical machine, the whole job of organizing production there reduces to supplying it with a tape-recording of the work program of the production line. No time has to be lost in mastering output of the product or training personnel. It is obvious that such possibilities make industry much more mobile and create an entirely new situation in planning production.

Whereas it is still expedient in certain cases to use devices of a rigid type in controlling machine tools and machine tool production lines, numerical control machines prove to be the only possible solution of the problem when it is a question of switching over big industrial enterprises like plants and power grids to automatic control. These machines must "remember" the data they receive about the work, say, of certain installations in the enterprise, compare them with the figures given in the program, and issue the commands which will ensure that the required work conditions are adhered to. The creation of such machines is no longer fraught with any technical difficulties.

With the help of such machines it is possible to establish the most advantageous operation conditions for an enterprise, i.e., to realize so-called "extreme regulation", where the control machine periodically probes the possibility of improving the basic technological indices by making certain changes in the operation conditions.

A simple example of extreme regulation is furnished by the numerical machine for aircraft, which can ensure the most economical consumption of fuel by its engines. It is known that the quantity of fuel burned depends in a complicated way upon a number of factors: the load, the altitude of flight, and the weather conditions. The plane crew cannot constantly keep an eye on all the changes in atmospheric and other flight conditions, and calculate and introduce corrections into the work regime of the engines. The numerical system, upon receiving data characterizing these factors from automatic instruments and working them up, can so regulate the work regime of the engines that it will always be optimum.

A big role can be played by universal numerical and data processing machines in automatizing the analysis of complicated systems and preparing the necessary means for their control. What we have in mind here are such systems like an entire branch of industry, the banking system of a country, the railway system, or the civil air lines.

One can imagine a huge data processing machine which, at definite intervals, will receive data on the output of all big enterprises of some branch of industry, the raw-material stocks, the condition of the machine-tool equipment, and supply of labour power, and, on the basis of this data, supply information on the situation, or, upon comparing this data with the plan, supply information on plan fulfilment, on possible production reserves. It goes without saying that such a machine cannot control production. This will be the job of the people managing the corresponding branches of industry, but with such a machine available, the possibility of making correct decisions that take into consideration the entire situation would be greatly enhanced.

The programs required for such machines fall into the class of logic programs, such as, the program for automatic language translations with the help of machines. Definite progress has been made in the solution of this problem in the Soviet Union. Certain results have been obtained, for instance, in the field of automatizing the compilation of programs for translation and economic coding. This is of considerable importance, since the first variants of programs for translations, which had to be compiled with the help of mathematicians and philologists, contained up to 20,000 commands and numbers. Solution of these problems will enable us to tackle the solution of other intricate logic programs as well.

Application of numerical systems in industry both to control individual machine tools, production lines and entire enterprises and to analyse the work of groups of enterprises and branches of the national economy will be a big step forward in the field of technical progress and also in improving the organization of production.

PYROCERAM

THE Corning Glass Works has reported the development of a new substance, Pyroceram, that is harder than steel and lighter than aluminium. Pyroceram starts out as glass and is melted and fashioned in the same way. But each batch of raw material includes chemical ingredients that contain a nucleating agent, which, under heat treatment, forms crystals. Glass is non-crystalline, whereas Pyroceram is crystalline.

The new material can be cast like metal in a foundry, thus allowing the fabrication of large and complex shapes. The substance is extremely hard and fine-grained. It can be made transparent or opaque and, by controlling the chemical composition and growth of the Pyroceram crystals, materials of widely differing properties can be produced. (*Science*, Vol. 125, 14th June 1957.)

BIOGENESIS OF NATURALLY OCCURRING 3- AND 4-PHENYLCHROMAN DERIVATIVES AND BENZOPHENONES

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Department of Chemistry, University of Delhi, Delhi

3-Phenylchroman Derivatives

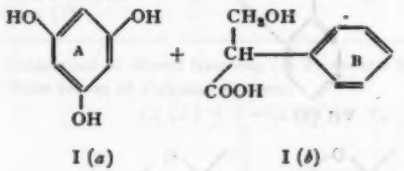
IN a recent publication[1] it was pointed out that C_9 units with the forked arrangement occur in nature fairly widely. Besides tropic acid (I b), polyporic and pulvinic acid derivatives form substantially numerous groups. Isoflavones, which too have this C_9 unit, have also become a large and important group of plant products. To this should be added the isoflavan derivatives, pterocarpin (II) and homopterocarpin occurring in a number of woods and barks.[2,3] Angolensin (III) which also occurs in certain woods of the *Pterocarpus* species[4,5] is closely related. A more recent discovery is wedelolactone[6] (IV) which is a 3-phenyl coumarin derivative analogous to pterocarpin and homopterocarpin. On account of the large number of types in which the forked C_9 unit occurs, it should be recognised as an independent structural unit just as the linear C_9 unit and as being directly involved in the biogenesis of 3-phenyl-chroman derivatives.

An alternative possibility is to regard the isoflavan structure to be the result of migration of the aryl group from the 2- to the 3-position of the normal flavan (see Robinson[7]). Such migration is known in the degradative study of catechin[8] and in the action of lead tetra-acetate on flavanones.[9] But this idea of the migration of the aryl group is not applicable to all the cases containing the forked C_9 unit. Hence it could be reasonably concluded that isoflavone, isoflavan and 3-phenylcoumarin derivatives are built from phloroglucinol (I a) and tropic acid (I b) units.

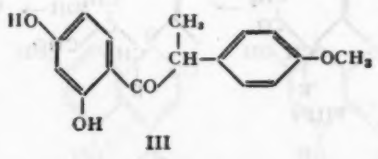
Geissman and Hinreiner,[10] who discussed the various possibilities of the biogenesis of the isoflavan skeleton, have stated that 'the condensation of C_6(B)-iso-C_3 with C_6(A) is mechanistically and biochemically plausible but lacks the support which would be furnished by the existence of C_6(B)iso-C_3 compounds in nature'. This objection may no longer exist because of the study of pulvinic acid and polyporic acid derivatives.

4-Phenylchroman Derivatives

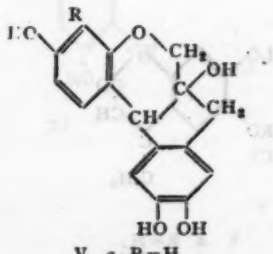
4-Phenylchroman derivatives have been rather rare. Brazilin (V a) and hæmatoxylin



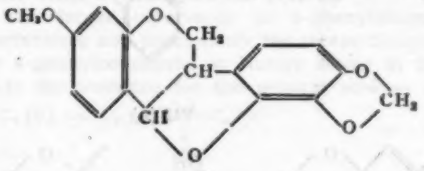
I (a) I (b)



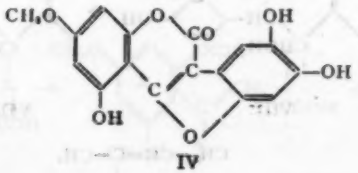
III



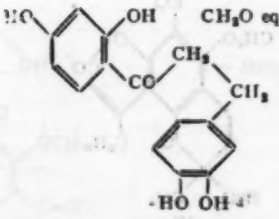
V a, R=H
b, R=OH



II



IV



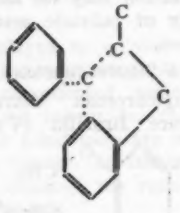
VI

(V *b*) were the only examples for a considerably long time and Robinson[11] indicated a possible relation with dihydro-butein (VI) which is undoubtedly a 2-phenylchromanone derivative. But he also noted the difficulty of explaining the location of the aliphatic hydroxyl group.

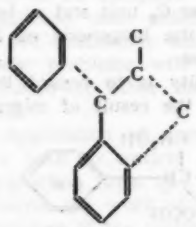
Geissman and Hinreiner[12] considered two possibilities (VII *a* and *b*) in which the C_6 and C_9 units of flavans could incorporate a single carbon to yield the brazilin type. They have preferred the latter (VII *b*) as more probable. This may mean the assumption of a 4-phenylchroman derivative as intermediate.

More recently Whalley[13] also adopted the 4-phenylchroman as the basic skeleton, but for its formation suggested an extension of the idea of migration originally applied for the formation of an isoflavan from a normal flavan. He proposed a further shift from the 3-phenyl (VIII) to the 4-phenylchroman (VIII *a*) and pointed out that this solved the abovementioned difficulty about the location of the aliphatic hydroxyl group.

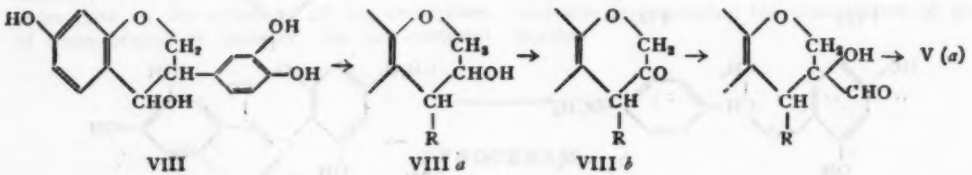
The main point that Whalley made out for suggesting the double migration was that there were few 4-phenylchroman derivatives occurring in nature. Recently more members of the 4-phenylchroman group have been discovered in plant products. Calophyllolide[14] (IX) obtained from the fruits of *Calophyllum inophyllum* has been shown to be a 4-phenylcoumarin derivative. Dalbergin (X *a*) and methyldalbergin (X *b*) are examples of simpler 4-phenylcoumarins and they are found in the wood of *Dalbergia sissoo*.[15,16] Consequently this type should also be considered to be the result of a more direct path of biosynthesis. The units involved would appear to be the same as in normal flavans, *i.e.*, phloroglucinol unit and C_9 linear unit. But the α-carbon atom of the latter is used for linking with the former. In this connection may be mentioned the condensation of phenols with cinnamic acid to yield 4-phenyldihydrocoumarin.[17] The evolution of brazilin with the β-hydroxyl group seems to offer no difficulty in this scheme. The possible stages



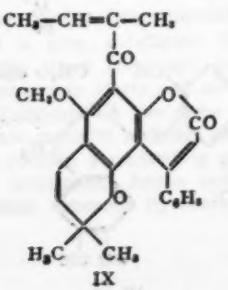
VII (*a*)



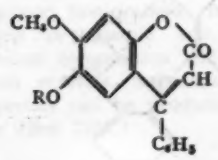
VII (*b*)



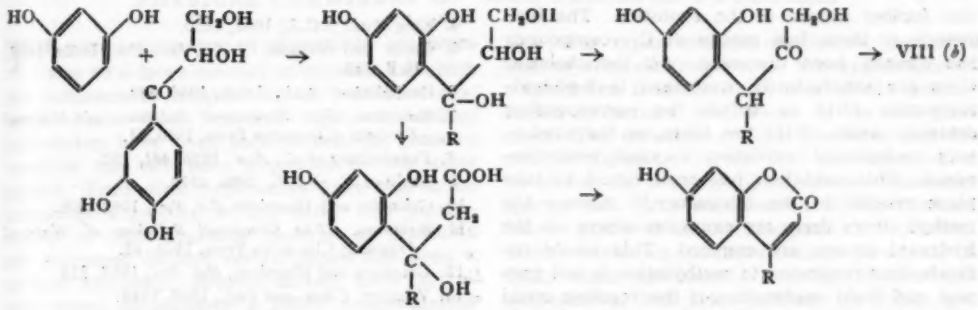
VIII VIII *a* VIII *b* V (*a*)



IX



X *a*, R=H
b, R=CH_3



BENZOPHENONES

TABLE I

Name	Formula: Position of hydroxyl groups	Formula: Position of methoxyl groups
Maclurin (*a*) ..	2, 4, 6, 3', 4'	..
Cotoin (*b*) ..	2, 6	4
Hydrocotoin (*b*) ..	2	4, 6
Methyl hydrocotoin (*b*)	..	2, 4, 6
Protocotoin (*b*) ..	2	4, 6 (3' : 4'-, methylene dioxy)
Methyl protocotoin (*b*) ..	..	2, 4, 6 (3' : 4'-methylene dioxy)
Para-Hydroxy benzophenone (*c*)	4	..

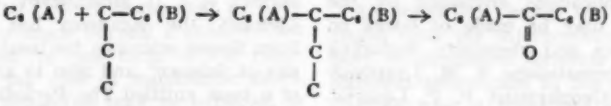
(*a*) From wood of *Morus tinctoria*, (*b*) From *Cotto* Bark
(*c*) From leaves of *Talauma mexicana*.

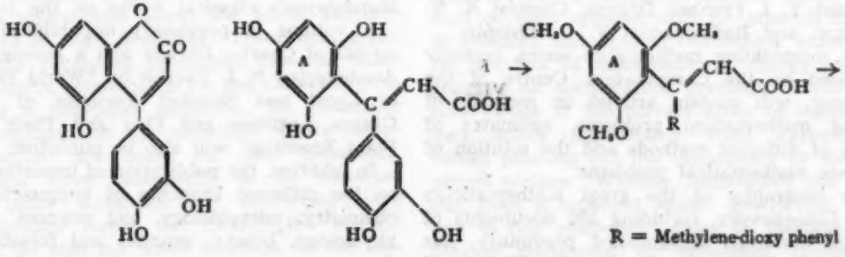
indicated above are analogous to what has been suggested in the case of normal flavonoids.[18,19] The α-ketonic C_9 unit employed is similar to related ketones occurring as lignim units.

Geissman and Hinreiner[20] noticed the close similarity in substitution pattern between naturally occurring benzophenones (see Table I) and flavonoids. As one of two possible methods of their formation they suggested the linking of the C_6(A) and C_9(B) parts through an α-carbon of (B) and subsequent degradation of the C_{15} unit.

But they felt they had no compelling evidence to support it. The frequent methylation of the compounds was also recognised by the above authors who suggested that methylation was a later stage in the synthetic process.

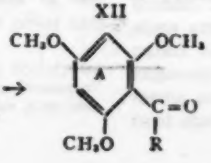
The larger occurrence of 4-phenylchroman derivatives and particularly the recent discovery of 4-phenylcoumarins in Nature seems to provide the evidence for the general scheme and





R = Methylene-dioxy phenyl

XI XII



also further details of the evolution. The biogenesis of these two groups of C_{15} compounds has already been discussed. All the observations are satisfactorily explained if 4-phenylcoumarins (XI) or better the corresponding coumaric acids (XII) are taken as the precursors undergoing oxidation to yield benzophenones. This oxidation has been found to take place readily in the laboratory.[15] Among the methyl ethers there are examples where all the hydroxyl groups are engaged. This would indicate that resistance to methylation is not present and finds explanation if the reaction could be considered to take place at the coumaric acid stage (see XII) in these cases. For the formation of the partial methyl ethers the benzophenone stage may be suitable.

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17. Simpson and Stephen, *J.C.S.*, 1956, 1382.
18. Robinson, *Nature*, 1936, **137**, 172.
19. — *et al.*, *Phil. Trans. Roy. Soc.*, London, 1939, **230 B**, 149.
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PUBLICATION OF SCIENTIFIC LITERATURE IN USSR DURING 1957

THE USSR Academy of Sciences will put out close to 1,500 titles and issue of Journals totalling 32,000 signatures in 1957. The range of subjects will cover all spheres of the humanitarian, natural and technical sciences.

In the scientific and technical part of the programme of publications envisaged by the Academy, mention may be made of books on mathematics, physics and chemistry, including works by the mathematicians A. M. Lyapunov and N. N. Luzin, Geophysicist P. P. Lazarev, Physicist Y. I. Frenkel, Organic Chemist A. N. Butlerov, and Radiochemist V. G. Khlopin.

The computation mathematics series, recently organised by the Computation Centre of the Academy, will contain articles on methods of solving mathematical problems, estimates of errors of different methods and the solution of concrete mathematical problems.

The biography of the great mathematician N. I. Lobachevsky, including 360 documents of archive materials unpublished previously, has been prepared by the Institute of History of Natural and Technical Sciences.

Revised and supplemented editions of Academician A. F. Joffe's *Physics of Semi-Conductors* first issued in 1955, will be put out, as also L. I. Brekhovakikh's monograph on "Waves in Layered Media".

To commemorate the Fiftieth Death Anniversary of I. D. Mendoleyev, the great Russian Chemist, the Academy has collected articles from Soviet scientists for issuing them as "Classics of Science" and also to arrange publication of a book entitled *The Periodic Law*, describing Mendoleyev's classical works on the subject.

A volume of previously unpublished manuscripts of Charles Darwin and a monograph by Academician N. I. Vavilov on "World Resources of Local and Selected Varieties of Cereals, Grains, Legumes and Flax and Their Use in Plant Breeding" will also be published.

In addition, the publication of important books on the different branches of engineering, biochemistry, microbiology, soil sciences, zoology, physiology, botany, genetics and forestry is in the programme.

PHYSICAL CHEMISTRY OF HIGH PRESSURE PROCESSES*

THE comparative ease of observation has given rise to a large amount of material in which the influence of temperature on condensed systems have been studied and theoretical approaches have been possible but the pressure variable has not been exploited to the same extent. Theoretical approaches have had to be primarily a groping in the dark. The permeability of most available material as pressures are increased beyond certain limits has been a serious handicap. Several factors have in recent times necessitated a fuller understanding of high pressure processes. Industrial interest aroused after the production of polyethylenes, the study of explosives and explosion reactions, the development of 'atomic' armaments, all these call for a stock-taking of the present position and as is usual with Faraday Society Discussions from its inception, the present report focusses the attention of scientific workers on the different aspects of the problem. The contributions are in three sections, a theoretical group dealing with electromagnetic properties and energy transport processes, a group of papers on chemical reactions and transformations at high pressures and lastly, a group dealing with detonations.

While the classical work of the nineteenth century indicated the existence of attractive forces between molecules, the need for considering repulsive forces at close approaches was clearly indicated by London who considered the repulsion potential to be exponential. The analysis by Cottrell shows that we have not advanced very much beyond a confirmation of the correctness of the form of the function, at least in the case of monatomic gases. Several physical properties may be expected to give us information about the forces between molecules at high pressures. Theoretical generalisations regarding properties like the Clausius-Monsotti relationship for the dielectric constant of a non-polar molecule, the molecular Kerr constant and the molecular Cotton Mouton constant are based on ideal behaviour. Deviations have necessarily to be expected where polar molecules are concerned since intermolecular forces can modify the electric moment as also the wave function of the isolated molecule. The spectral studies of the French contributors on mixed gases of polar and non-polar types indicate clearly the perturbation of allowed frequencies, the appearance of combination frequencies as well as the perturbation of induced frequencies in the non-polar gases. The influence of high pressures and the role of repulsion forces may be expected to be shown in a study of electronic resonance spectra and by a combination of the Lennard Jones potential with Margeneau's statistical theory involving a perturbation potential, a fairly close agreement, both qualitative and quantitative, has been noticed by Robin and others.

One of the clearest indications of intermolecular forces can be expected from a study of characteristic frequencies especially of bonds containing hydrogen. A study of several such compounds in a number of non-polar solvents has clearly shown a correlation between the shift in frequencies with pressure and there also seems to be a specific pressure coefficient characteristic of each bond.

From theoretical consideration based on the material provided by astrophysicists, metallic conduction may be expected in many insulating materials whenever, as a result of the high pressures, the highest filled band overlaps an unoccupied higher band. By the use of the high detonation pressures of the shock waves generated by explosives, Alder and Christian have been able to demonstrate the phenomenon with cæsium iodide, red phosphorus and lithium aluminium hydride single crystals.

An important group of problems are associated with the interpretation of energy transport in condensed systems and we have two different approaches to the problem. Longuett-Higgins uses a simplified kinetic theory of a fluid of hard spheres with no internal degrees of freedom and obtains convenient expressions for the flux of momentum or energy under a pressure or temperature gradient. While these give values of the correct order of magnitude, they differ appreciably from experimental values pointing out the inadequacy of the simplified picture. Whalley approaches the problem from a different angle. Restricting attention to one component gases in thermal equilibrium containing the monomer, dimer and trimer, neglecting the effect of inelastic collisions and assuming large mean free path compared to molecular diameters, he obtains the expression for energy transport involving four terms and shows that in the region of the critical state, most of the conduction is due to the

* A General Discussion of the Faraday Society on "The Physical Chemistry of Processes at High Pressures" held on the 20th and 21st Sept. 1956. (The Aberdeen University Press, Ltd., Aberdeen, Scotland.)

transport by conduction and by the transport of internal energy of clusters.

The difficulties in experimental techniques have stood in the way of a fuller study of the influence of pressure on chemical reactions on lines similar to the influence of temperature. The section on chemical reactions is useful, particularly in whetting one's interest by showing the very limited work that has been possible so far. The provocative contribution of Laidler develops the classical van't Hoff picture of the influence of pressure on equilibrium constants and considers them from the picture of volume changes in the overall reaction or activation process. In ionic reactions, the ionic volume can be the sum of two terms made up of the intrinsic volume of the ion and a term related to the electrostriction of the solvent molecule in its neighbourhood. The general considerations advanced lead to a certain amount of correlation between molar volume changes and temperature coefficients of these changes in dealing with solvent influences and the results available appear to give some support to the speculative concepts on the role of electrostriction in solvent influence on reactions. While the free radical decomposition of benzoylperoxide shows no significant mechanistic change with pressure, in styrene polymerisation, initiation is little influenced by pressure though propagation of the reaction chain is noticeably affected. The difficulty in generalisation is clearly shown by work on ethylene which appears to suggest that in catalysed reactions under pressure, mechanistic changes are also possible with consequent changes in the overall activation energies. Similarly liquid phase studies lead to changes in reaction rates very much larger than changes in molar volumes.

The last section of the symposium starts with an excellent summary of the basis of detonation theory which, however, is not adequate for one unfamiliar with the field to follow the subsequent contributions. We have in the section an indication of the techniques involved in the study of explosions and measurements of detonation velocities in compressed acetylene, a useful summary of probable reaction mechanisms in the region of the detonation wave and studies on solid explosives. We notice here not only the difficulty in the experimental techniques but also the very limited knowledge we possess on the subject.

In such a valuable symposium, one cannot help noticing the absence of contributions from astrophysicists.

S. V. ANANTAKRISHNAN.

SYMPOSIUM ON "RECENT DEVELOPMENTS IN FOUNDRY TECHNOLOGY"

THE Symposium scheduled to be held at Jamshedpur in the first week of February 1958, has been arranged by the National Metallurgical Laboratory, Jamshedpur, in active collaboration with the Indian Institute of Foundrymen.

The main object of this venture is to study the latest scientific developments that have taken place all the world over with regard to the heavy machinery and engineering industries and to help the industrial expansion of India envisaged during the Second Five-Year Plan.

The Symposium will cover the following subjects: (1) Raw materials for moulds and cores; (2) Materials and methods for fettling and handling of materials in the foundry; (3) Modern innovations in foundry technology like CO_2 process, shell-moulding; (4) New developments in melting including casting techniques and latest equipment; (5) Recent developments in the founding of ferrous and non-ferrous metals and alloys; (6) The position of foundry industry in India *vis-a-vis* Second Five-Year Plan; (7) Foundry mechanisation and layout; (8) Foundry management.

Technical papers to be presented at the Symposium and other correspondence may be addressed to: Dr. T. Banerjee, Assistant Director, National Metallurgical Laboratory, Jamshedpur-7.

An Exhibition depicting the present stage of Indian Foundry Industry's progress in relation to future expansion plans is also proposed to be aranged at the National Metallurgical Laboratory.

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THE EMISSION SPECTRUM OF ALUMINIUM MONOCHLORIDE IN THE ULTRAVIOLET AND SCHUMANN REGIONS

It is known from the early work (Chrétien, 1950; Barrow and Rowlinson, 1954; Naudé and Hugo, 1955), on the related diatomic fluorides of boron and aluminium, that these molecules give rise to numerous band systems in the far and vacuum ultraviolet regions. Most of these have been interpreted as arising from the ground state of these molecules to various upper electronic levels. This early work suggests the possibility of the existence of analogous band systems in the spectra of the chlorides and bromides of aluminium. The present note describes the results obtained in the case of the emission spectrum of aluminium monochloride investigated in the region from λ 2300-λ 1800.

In the present experiments, a pure sample of anhydrous aluminium trichloride supplied by B.D.H. was used and the spectrum was excited by a 50-watt high frequency oscillator when continuous low pressure vapour conditions are maintained in an ordinary discharge tube. The spectra were taken on a one-metre normal incidence vacuum grating spectrograph having a dispersion of 17·3 Å/mm.

The spectrum, which was obtained free from any trace of impurity, is reproduced in Plate I. As can be seen, most of the bands (about 30 in number) belong to six discrete band systems which are here designated as systems I, II, III, IV, V and VI starting from the longer wavelength side. Bands belonging to systems I, II, IV and VI are violet-degraded while those belonging to systems III and V are seen to be red degraded. All the systems are interpreted as due to transitions from the various upper

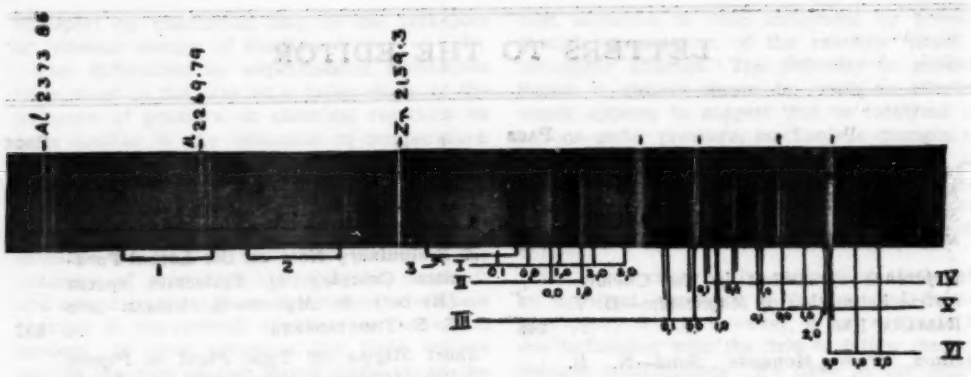

PLATE. 1. Emission Spectrum of AlCl. 1, 2 and 3 : Continua; I—VI : Band systems.

electronic states to the common ground state of the AlCl molecule.

The ν_{00} values and the approximate values of ω_e' and ω_e'' are given in Table I. The last column gives the vibrational assignments of bands belonging to various systems. In addition to the above band systems, three characteristic continua were recorded in the wavelength regions λλ 2320-2260, λλ 2240-2170 and λλ 2110-2060 (Plate I).

TABLE I

System	Region of occurrence	ν_{00} cm.$^{-1}$	Approx. ω_e' cm.$^{-1}$	Approx. ω_e'' cm.$^{-1}$	Remarks
I	λλ2075–1990	48664	505	481	Consists of five violet degraded bands identified as (0, 1), (0, 0), (1, 0), (2, 0) and (3, 0)
II	λλ2040–2015	48996	514	..	Two violet degraded bands assigned as (0, 0) and (1. 0)
III	λλ1960–1925	51451	413	482	Consists of three sequences of bands degraded towards the longer wavelengths. Assignments shown
IV	λλ1935–1895	52102	537	477	Also consists of three sequences of bands. Assignments shown
V	λλ1905–1855	53045	377	481	Comprises of four bands. Assignments shown
VI	λλ1855–1820	53851	513	481	Consists of 0, 0 ; 1, 0 and 2, 0 sequences of which the 0, 0 sequence is well known

Details of the analysis and nature of the electronic states will appear elsewhere.

We are indebted to Prof. Sieghbahn who has kindly supplied the grating to Prof. K. R. Rao. One of the authors (S. P. R.) is grateful to the Government of India for the award of a Senior Research Scholarship.

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INTERFERENCE OF ANIONS IN THE CHELATOMETRIC ESTIMATION OF MAGNESIUM

THE quantitative estimation of magnesium in a sample of dolomite or cement is difficult. The procedure involving double precipitation of the calcium as oxalate followed by double precipitation of the magnesium as the ammonium phosphate is accurate but time-consuming. Removal of calcium as $CaMoO_4$[1] and as CaF_2[2] were also suggested. More recently[3] chelatometric methods involving the use of various indicators and pH control are listed in a supplement. Magnesium can be estimated[4] in a NH_4Cl-NH_4OH buffered medium (pH 10) by titrating against disodium salt of EDTA using Erichrome black T as indicator to a change in colour from wine red to blue. The interference of several cations was known. During the removal of calcium as CaC_2O_4, CaF_2 and $CaMoO_4$, the filtrate containing magnesium will be impure with the excess of the precipitants, viz., oxalate, fluoride and molybdate respectively. The interference of these anions in the complexometric estimation of magnesium does not seem to have been studied.

Standard solutions of magnesium sulphate and disodium salt of EDTA were prepared. A definite volume of magnesium sulphate solution was taken (0·3764 g. of $MgSO_4.7H_2O$) and the magnesium content was estimated according to the method reported earlier.[4] Addition of either sodium fluoride solution or ammonium oxalate solution brought about the change in colour from wine red to blue even without the addition of the titrant. This interference is as expected since fluoride and oxalate are established complex-forming ligands and this aspect will be studied in greater detail later on. Molybdate was however found not to interfere in the titration. The estimation of magnesium in the presence of molybdate (ranging between 0·1654 g. and 1·654 g. of $Na_2MoO_4.2H_2O$) remains unaffected.

Preliminary experiments revealed that round about pH 2·5 where molybdenum exists[5] as a divalent cation MoO_2^{++} in an appreciable concentration, addition of this complexone prevented the precipitation of chocolate-coloured precipitate $(MoO_2)_2\,Fe(CN)_6$ indicating the formation of a stable metal chelate. Recently, catechol violet was used[6] as an indicator for complexometric titrations at lower pH ranges between 2 and 3. It is therefore intended to develop a chelatometric method for estimating molybdenum using either catechol violet or any other suitable indicator.

Thanks are due to the B. S. I. R., Orissa, for a grant, and to the M.Sc. students for bringing this problem to my notice and their interest in the work.

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HELIUM FROM MONAZITE SAND

EVER since Ramsay's discovery of helium in radioactive minerals, various attempts have been made to separate helium from monazite sand. The methods employed were in general:

(*a*) heating the powdered mineral with sulphuric acid or alkali sulphates, and

(*b*) direct heating of the sand to high temperatures.

Ramsay and Travers,[1] Strutt,[2] Henrich[3] and Tendolkar[4] heated monazite with sulphuric acid or alkali sulphates under different experimental conditions and their reported values of helium vary from 0·1 to 2·4 c.c. per g. of monazite sand. Taylor[5] and others[6–8] heated monazite sand at 900–1,200° C. for different time intervals and obtained values of 0·6 to 1 c.c. He/g. of monazite sand. Subbaraman and Krishnaswamy[9] heated monazite sand of 40 and 80 mesh for 4 hr. at 1,000–1,100° C. in a Topler vacuum and obtained 0·850 c.c. and 0·903 c.c. He/g. of monazite respectively. The present work deals with the determination of helium from Indian monazite sand by caustic treatment under the experimental conditions employed at the Indian Rare Earths Limited, Aiwaye, where monazite sand ground to 300 mesh is digested with 70% caustic soda solution at 150° C. for 4 hr.

The apparatus consisted of a mild steel reaction vessel connected on to a gas holder through a water-cooled condenser and a topler pump. Three different samples of monazite sand obtained from the Indian Rare Earths Limited, Alwaye, were heated in the reaction vessel for 2 hr. and 4 hr. under the above-mentioned experimental conditions. The gases liberated during the reaction were collected in the gas holder over saturated salt solution and at the end of the reaction all the gases present in the system were pumped out into the gas holder. The volume of gases liberated during the reaction was ascertained by knowing the volume of air present initially in the system before starting the reaction. The gas in the gas holder was first analysed for O_2, CO_2, CO and H_2 with the help of an Orsat apparatus and the residual gas was then analysed for its helium content. The apparatus for the determination of helium was an adaptation of the one used by Germann, Gagos and Nielson[10] and the method is based on the ability of charcoal to absorb all gases except helium, neon and hydrogen when cooled in liquid air.

It was found that on an average 0·76 c.c. and 0·78 c.c. of helium are liberated at the end of 2 hr. and 4 hr. respectively from 1 g. of Indian monazite by fusion with 70% caustic soda solution at 150° C.

Thanks are due to Dr. Jagdish Shankar, Chemistry Division, Atomic Energy Establishment,

for giving us the facilities to carry out this work.

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AN ION-EXCHANGE METHOD FOR THE SEPARATION OF THORIUM FROM RARE-EARTHS AND ITS APPLICATION TO MONAZITE ANALYSIS

MOST of the analytical methods for the separation of thorium from rare-earths involve repeated precipitations.[1] Radhakrishna[2] used a cation-exchanger, Amberlite-IR 100 for the separation of thorium from lanthanum. His method has the disadvantage that for their recovery, double elution must be carried out first of lanthanum and then of thorium.

A simpler method has been developed for the separation of thorium from rare-earths based on the observation that from a sulphate solution (pH 1-2) thorium is adsorbed on a strongly basic ion-exchanger, like Amberlite-IRA 400 in the sulphate form, probably as an anionic sulphate complex, while rare-earths are not. Thorium is subsequently eluted with 2 N hydrochloric acid and estimated. Some of the results are shown in Table I.

TABLE I
Separation of thorium from cerium

Expt. No.	Thorium taken mg. ThO_2	Cerium taken mg. CeO_2	Thorium found mg. ThO_2	Cerium found mg. CeO_2
1	100·0	..	100·5	..
2	40·0	5·0	40·2	5·0
3	40·0	5·0	39·7	4·8
4	20·0	200·0	20·2	198·0
5	20·0	200·0	19·5	201·0

This method has been applied for the determination of thorium and rare-earths in monazite concentrates. Briefly, the procedure consists of the following steps:

(i) Fusion of the powdered sample with potassium bifluoride.
(ii) Separation of thorium and rare-earth fluorides.
(iii) Conversion of these fluorides into sulphates, and
(iv) Separation and subsequent estimation of thorium and rare-earths using the ion-exchange method described above.

The details of the procedure with full results will be published elsewhere.

We thank Dr. Jagdish Shankar, Atomic Energy Establishment, and Dharma Veer Bhatnagar, for their encouragement and helpful suggestions during the course of the work.

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TURBIDITY TEMPERATURE: A SIGNIFICANT FIGURE FOR JUDGING THE PURITY OF SESAME OIL

IN the course of the analysis of samples of sesame oil received under the Prevention of Food Adulteration Act, it was found that the standards prescribed for the oil under the rules were inadequate for the detection of arachis oil when present as an adulterant. The standards for sesame oil under the rules are:

Butyro-refractometer reading at 40° C.—58·0 to 61·0.
Saponification value—188 to 193.
Iodine value—105 to 115.
Unsaponifiable matter—not more than 1·5%.
Free fatty acids—not more than 3·0%.

The detection, let alone the estimation, of quantities as high as 20% of arachis oil in adulterated sesame oils on the basis of these standards is impossible. The iodine value and the Butyro-refractometer reading of the two oils, which alone of the prescribed standards are relevant for judging purity, do not differ sufficiently to enable the detection of marginal adulteration. It was considered that the turbidity temperature based on the Bellier test would serve the purpose. Hawley[1] found that sesame oil has a characteristic turbidity tem-

perature of 20° C. and arachis oil 40° C. Narayanier,[2] in an extensive study of the test, modified these figures to 19-20° C. and 39-40° C. respectively, and showed how the turbidity temperature could be employed for the quantitative determination of arachis oil in admixture with various vegetable oils.

The following series of tests were carried out using five samples each, of genuine sesame oil and arachis oil as starting material. Artificial mixtures were prepared from these, containing 5, 10, 15 and 20% of arachis oil. The iodine value and Butyro-refractometer reading of these mixtures were determined. In addition the turbidity temperature was also determined in the manner described by Narayanier.

The results for the genuine sesame and arachis oils and the prepared mixtures are given below:

TABLE I

Giving the Iodine value, Butyro-refractometer reading and turbidity temperature of genuine samples and mixtures of sesame and arachis oils

Test sample	Turbidity temperature ° C.	Iodine value	Butyro-refractometer reading at 40° C.
Genuine Sesame oil ..	19·5–20·5	109–115	58·8–59·8
Genuine Arachis oil ..	39·5–40·0	95–97	54·9–55·5
Sesame oil with 5% Arachis oil	21·5–22·5	108–114	58·4–59·6
Sesame oil with 10% Arachis oil	23·0–23·5	107–113	58·3–59·4
Sesame oil with 15% Arachis oil	24·0–24·5	106–112	58·2–59·1
Sesame oil with 20% Arachis oil	25·5–26·5	105–111	58·0–58·9

It will be seen from Table I that the iodine value and Butyro-refractometer reading of sesame oil-archis oil mixtures containing up to 20% of arachis oil fall within the range prescribed for sesame oil under the rules. Consequently, on the basis of these two figures, such mixtures will have to be certified as genuine sesame oil by the public analyst even though they contain up to 20% of arachis oil.

But it will be noted that the turbidity temperature of sesame oil is significantly altered by admixture with even 5% of arachis oil. A figure over 21·0 not only definitely proves adulteration, but also enables the calculation of the percentage of arachis oil present. Hence it is suggested that the turbidity temperature of 19·0 to 21·0 may also be included in the rules as an additional standard.

We thank Sri. S. Narayanier, Government Analyst, Madras, for his interest in this work.

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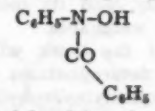
N-BENZOYLPHENYLHYDROXYLAMINE AS ANALYTICAL REAGENT FOR ESTIMATION OF MOLYBDENUM

To improve upon certain defects of cupferron, C_6H_5-N-ONH_4, Shome[1,2] prepared various deri-

vatives of phenylhydroxylamine and made a preliminary study of their analytical properties. He introduced N-benzoylphenylhydroxylamine,



for the gravimetric determination of copper, iron, aluminium and titanium. Unlike cupferron (in the acid form), N-benzoylphenylhydroxylamine is stable towards heat, light and air, and the reagent is soluble in hot water.

In the present investigation N-benzoylphenylhydroxylamine has been employed for the analysis of molybdenum. The organic reagent precipitates molybdenum quantitatively from molybdate solutions acidified with varying amounts of hydrochloric acid. The metal is precipitated by adding alcoholic solution of N-benzoylphenylhydroxylamine in slight excess to the acidified molybdate solution. The molybdenum precipitate is then filtered, washed, ignited and weighed as molybdenum trioxide.

The results obtained are recorded in Table I.

TABLE I

Determination of Molybdenum with N-benzoylphenylhydroxylamine

Molybdenum metal taken g.	Acidity of molybdate solution, N	Molybdenum trioxide found, g.	Molybdenum metal found, g.	Error g.
0·06082	0·03	0·0908	0·06049	−0·00033
0·06082	0·03	0·0910	0·06066	−0·00016
0·06082	0·02	0·0904	0·06026	−0·00056
0·07701	0·01	0·1150	0·07666	−0·00035
0·07701	0·6	0·1152	0·07679	−0·00022
0·07701	1·6	0·1160	0·07729	+0·00028
0·07701	2·5	0·1159	0·07726	+0·00025

The molybdenum complex corresponds to the formula $MoO_2(C_{13}H_{10}O_2N)_2$ and can also be weighed directly.

The effect of various ions on the precipitation of molybdenum is studied and it is observed that hexavalent chromium and small amounts of trivalent iron do not interfere with the determination of the metal. Molybdenum can be separated from pentavalent vanadium and appreciable amounts of trivalent iron when the two latter metals are present as stable soluble complexes. In strong acid media molybdenum can be determined in the presence of nickel and copper.

N-benzoylphenylhydroxylamine has advantages over α-benzoinoxime[3]: the former reagent can be used for the determination of molybdenum in the presence of hexavalent chromium and pentavalent vanadium without reducing them to trivalent and quadrivalent states respectively, and its molybdenum complex is directly weighable.

The details of the work will be published elsewhere. The determinations of other metals with N-benzoylphenylhydroxylamine are in progress.

Presidency College, Calcutta-12, *May* 22, 1957.

S. K. Sinha.
S. C. Shome.

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A 'POD MUTANT' IN GRAM (*CICER ARIETINUM* LINN.)

During the course of botanical studies in gram at the Agricultural Research Station, Niphad, a large collection of gram varieties is being maintained and studied. In 1950-51 season, a plant having abnormal arrangements of pods, distinctly different as compared to the normal gram plants, was observed, in the culture 'Himayat Sagar'. This plant arose spontaneously and is breeding true for the last six years.

In normal gram plants, flower buds grow out into the light and air as they open; later on, the pedicel begins to get bent at the joint and by the time the flower has faded, the bending is complete and thus the pods are found to droop down and develop below the surface of the leaf (Fig. B).

A. B.

A—Mutant.
B—Normal.

In case of the mutant, the flower buds grow out into the light and air as they open; later on, the pedicel begins to get bent at the joint. However, by the time the flower has faded, the bending is incomplete and the pods, instead of drooping down, lie on the leaves along the internodes and are seen distinctly on the plant surface. This character has not been observed in the parental line. On close examination, it has been found that the length of pedicel is slightly more and that of the internode is slightly less as compared to the normal (Fig. A).

The detailed genetical behaviour of this mutant is under study. Though several mutations exhibiting new leaf and pod characters have been reported, this appears to be the first of its kind.

We are highly obliged to Prof. V. M. Chavan and Dr. S. Solomon for going through the article and giving valuable suggestions.

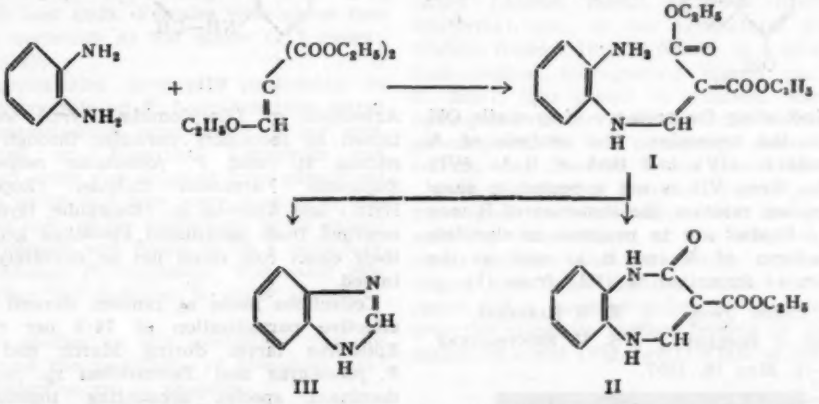
Agric. Res. Station, Niphad, District Nasik, *February* 22, 1957.

J. A. Patil.
B. B. Chaudhari.

CONDENSATION OF AROMATIC AMINES WITH DIETHYL ETHOXYMETHYLENEMALONATE

In view of the recent publications[1-3] concerning the formation of diazepines by the condensation of o-diamines and β-dicarbonyl compounds, it was of interest to explore the possibility of the formation of seven-membered ring systems (II) from o-phenylenediamine and diethyl ethoxymethylenemalonate—a potential β-dicarbonyl compound.

Sexton[4] synthesized the seven-membered ring compound from *o*-phenylenediamine and ethyl acetoacetate under neutral or alkaline conditions. Thiel and Steiming[5] prepared benzdiazine by the condensation of *o*-phenylenediamine and acetylacetone and Phillips[6] synthesized benzdiazatropone derivative by the condensation of the same with malonic acid. Two types of closure were predicted in the cyclization of the mono-condensation product (I);

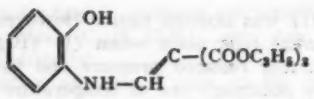


first, the formation of a six-membered ring leading to 8-aminoquinoline derivative, second, the formation of a seven-membered ring giving a diazatropone derivative (II). However, the formation of the five-membered ring (III) was predominant in the condensation with ethoxymethylenemalonate.

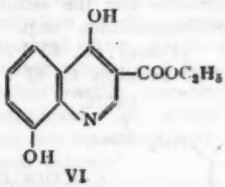
Product (I) which was obtained in 93·5% yield by heating on a water-bath *o*-phenylenediamine (1 mol.) and the ester (1 mol.) according to the method of Riegel *et al.*,[7] crystallized from petroleum ether (b.p. 60–80° C.), m.p. 92–93° (Found: C, 59·9; H, 6·2; N, 10·4 $C_{14}H_{18}N_2O_4$ requires C, 60·4; H, 6·4; N, 10·1%). When reacted with acetic anhydride (I) gave the monoacetyl derivative m.p. 154° (Found: C, 59·9; H, 6·5; N, 8·7. $C_{16}H_{20}N_2O_5$ requires C, 60·0; H, 6·3; N, 8·8%). Attempts were made to cyclize the mono-condensation product (I) and according to the procedures used by Reid and Hohne[8] to get diazepine. Benzimidazole (III) was obtained instead when the cyclization was attempted by refluxing (I) with 4 N HCl for half-an-hour. Evaporation of the ether extract of the neutralized reaction mixture gave benzimidazole, m.p. 171–72° C., which was not depressed when mixed with an authentic sample. By heating together *o*-phenylenediamine and the ester at varying temperatures from 150 to 220° C. for 1 to 2 hours, only the product (I) was isolated again. However, pyrolytic cleavage took place when (I) (10 g.) was distilled under reduced pressure and two fractions were obtained: one at temperature (bath) 130–60° C./1 mm. and the second at 230–60° C./1 mm. The first fraction (0·840 g.) was identified as benzimidazole and the second fraction (3·2 g.) as benzimidazolone, m.p. 311–12° C. (*lit.* 311–12° C.) (Found: C, 63·1; H, 4·5; N, 20·6. $C_7H_6N_2O$ requires C, 62·7; H, 4·5; N, 20·9%). The latter was also formed when (I) was heated in diphenyl ether—an usual method used to get quinoline ring system. No change occurred when (I) was heated in xylene for 3 hours in presence of a trace of alkali (NaOH).

To study the effect of substitution of NH_2 group by OH in (I), *o*-aminophenol was next condensed mith ethoxymethylenemalonic ester. The condensed product (IV) (yield quantitative), m.p. 143–44° C. (Found: C, 60·1; H, 5·9; N, 5·1. $C_{14}H_{17}NO_5$ requires C, 60·2; H, 6·1; N, 5·0%). When refluxed with dilute HCl gave only *o*-aminophenol, probably formed by the hydrolysis of benzoxazole formed as an intermediate. The distillation of (IV) *in vacuo* gave two fractions: fraction A at 120° C./2 mm. and fraction B at 180° C./2 mm. Fraction A was redistilled (b.p. 60–65° C./5–6 mm.) and analysed: C, 57·0; H, 6·1; N, 4·5. $C_{14}H_{17}NO_6$ requires C, 56·9; H, 5·8; N, 4·7%. Fraction B solidified and was crystallized from aqueous ethanol, m.p. 239–40° C. (Found: C, 62·5; H, 4·8; N, 5·5. $C_{12}H_{11}NO_4$ requires C, 61·8; H, 4·7; N, 6·0%).

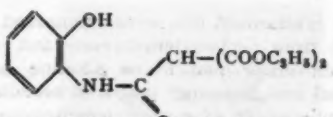
The product B was also obtained when the cyclization of (IV) was attempted in diphenyl ether. Both A and B showed ferric chloride colouration and coupled readily (under alkaline conditions) with benzenediazonium chloride,



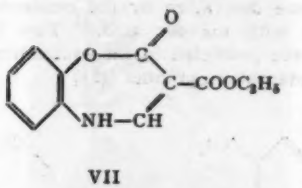
IV



VI



V



VII

thereby indicating the presence of aromatic OH groups in the molecules. The analysis of A corresponds to (IV) and that of B to (VI) or (VII). Since VII is not expected to show diazo coupling reaction, the structure of B may be (VI). Studies are in progress to elucidate the structures of A and B as well as the mechanism of formation of (III) from (I).

Dept. of Chem. Tech., University of Bombay, Bombay-19, *May* 16, 1957.

K. S. Sardesai.
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A PRELIMINARY NOTE ON THE LARVAL-PARASITES COMPLEX OF *EPILACHNA SPARSA* (HERBST) IN MYSORE

Epilachna sparsa[9] (Herbst) (Coccinellidæ, Col.) is a major pest of potato and brinjal, and it also infests certain other cultivated and wild Solanaceous plants.[5] Recent investigations showed for the first time the existence of a complex of at least seven species of parasites in the primary, secondary and possibly also tertiary roles, with the larva of *Epilachna* as the focal insect. *Pleurotropis foveolatus* Crawford, *P. epilachnæ* Rohwer (Eulophidæ, Hym.) and *Tetrastichus* sp. (Tetrastichidæ, Hym.) were taken as the primary parasites, *Tetrastichus* sp. also behaving as a secondary parasite through *P. foveolatus*. *Pleurotropis* sp. and *Aximopsis* sp. (Eurytomidæ, Hym.) were obtained as secondary parasites through *Tetrastichus* sp. and *P. foveolatus* respectively. *Euplemus* ?*urozonus* Dalman (Eupelmidæ, Hym.) and *Elasmus* sp. (Elasmidæ, Hym.) also emerged from parasitised *Epilachna* grubs, but their exact role could not be definitely ascertained.

Collections made at random showed a total effective parasitisation of 74·3 *per cent.* of *Epilachna* larvæ during March and April. *P. foveolatus* and *Tetrastichus* sp. were the dominant species accounting together for nearly 93 *per cent.* parasitisation, and these two were present in almost equal proportions and, therefore, exercised a considerable measure of natural control of the pest.

P. foveolatus was the only larval parasite of *E. sparsa* previously recorded from Mysore. It was originally described[3] from here and its biology studied.[1,5,9] *Pleurotropis* sp. nr. *foveolatus* was recorded on *E. niponica coalescens* Mader from China.[7] A species of *Pleurotropis* was reported to have exercised unusually effective control of *E. dodecastigma* Mulsant and *E. vigintioctopunctata* (Fabricius) in Uttar Pradesh.[6]

P. epilachnæ was described[10] as parasitic on pupæ of *Epilachna* sp. from Coimbatore. This is the first record of this species from Mysore. Its natural incidence was about 2 *per cent.*

Pleurotropis sp., a form recognizably distinct from either *foveolatus* or *epilachnæ*, was obtained from a pupa of *Tetrastichus* sp. within an *Epilachna* grub. Species of *Pleurotropis* were reported in the past as secondary and tertiary parasites on Hymeoptera.[2,8]

Tetrastichus sp.: Although our specimens seem to satisfy the original description of *Tetrastichus epilachnæ* by Giard,[4] Mr. Kerrich, who, at our request, kindly examined this series, finds that it is distinct from *T. epilachnæ* from Austria in the British Museum collection,

which was determined by Dr. Ferriere (*in litt.*).

It is one of the common species in Mysore, parasitising both grubs and pupæ of *Epilachna*. In laboratory it completed its development in 11 to 13 days at the average maximum and minimum temperatures of 87·4° F. and 78·1° F. respectively and the average relative humidity of 64 *per cent.* Superparasitism is the general rule, 2 to 22 (average 8·7) parasites emerging from each host grub. Females were about four times as numerous as the males (113 males : 408 females).

This species also developed consistently in the secondary role on *P. foveolatus*, the extent of hyperparasitisation being nearly 10 *per cent.* *Aximopsis* sp., *Eupelmus* ? *urozonus* and *Elasmus* sp. were also obtained from parasitised *Epilachna* grubs, but they were present in less than 1 *per cent.* of the parasitised larvæ examined. *Aximopsis* was found to be a secondary parasite through *P. foveolatus*. The exact role of the latter two parasites is under investigation.

Detailed studies on this interesting parasite complex and the possibility of biological control of *Epilachna* are in progress.

Thanks are due to Dr. M. Puttarudriah, Government Entomologist, for encouragement and guidance. We are most grateful to the Director, Commonwealth Institute of Entomology, London, for kindly furnishing the original description of *T. epilachnæ* and determination of *Tetrastichus* sp., *Aximopsis* sp. and *Eupelmus* ? *urozonus*.

Division of Entomology, Dept. of Agriculture, Bangalore, *July* 24, 1956.

S. Usman.
T. S. Thontadarya.

* This species has been regarded as *E. vigintiocto punctata* (Fabricius) by previous workers.

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SHORT STIGMA OFF TYPE PLANT IN PIGEON PEA (*CAJANUS CAJAN* MILLSP.)

The method of growing a crop strain in isolation, at a sufficient distance with barriers of other crops surrounding it, is followed in order to avoid contamination through cross-pollination, in the case of naturally cross-pollinated crops, such as pigeon pea (*Cajanus cajan*), onion (*Allium cepa*), safflower (*Carthamus tinctorius*), etc., at the Agricultural Research Station, Niphad, District Nasik. In a new, early, high-yielding, bold-grained pigeon pea strain N. 282-7, thus grown in isolation, one plant having few flowers and distinctly slow growth as compared to the remaining plants of the culture, was observed in the year 1955-56.

In young buds of a normal pigeon pea plant the stigma lies above the level of the anthers; with the development of the buds, the filaments elongate and the anthers surround the stigma and burst the day before the flower opens and a mass of pollen is distributed all over the stigmatic surface leading to the formation of a pod (Fig. *Left*). While in the young

Left: Normal.
Right: Short stigma

buds of the newly observed plant, the stigma lies just below the level of the anthers. With the development of the bud, the filaments as well as style elongate but the elongation of style is slow as compared to that of the normal, the stigma remaining far below the level of anthers. As a result, the stigma lies down below in the tube formed by the union of 9 stamens (diadelphous) and does not grow further at the time of bursting of the anthers; hence the stigmatic surface does not come in contact with the pollen, leading to sterility (Fig. *Right*). No seed, either open-pollinated or selfed, could be obtained in the year 1955-56. The plant was carefully maintained by watering. During 1956-57, the plant has profusely flowered and all attempts to get seed by selfing and crossing are being made.

A detailed study of this plant is in progress to ascertain whether it is a case of incompatibility or sterility.

We are highly obliged to Prof. V. M. Chavan for going through the note and giving valuable suggestions.

Agric. Res. Station, Niphad, District Nasik, *February* 22, 1957.

J. A. PATIL.
Y. N. SHEIKH.

A NOTE ON THE OCCURRENCE OF THREE-PORED HETEROCYSTS IN *MASTIGOCLADUS LAMINOSUS* COHN.

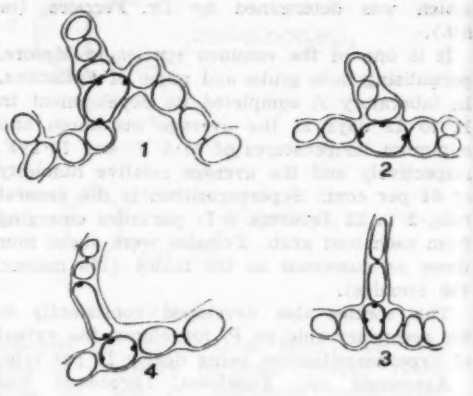
THE heterocysts of the blue-green algæ are usually either single-pored when they occur terminally (*cf. Cylindrospermum*) or by the side of a single branch (*cf. Tolypothrix*) or on either side of an intercalary biconcave disc or double-pored when they are intercalary in position (*cf. Scytonema*, etc.).

Iyengar and Desikachary[1] have reported for the first time, the occurrence of three-pored heterocyst in *Brachytrichia balani* (Lloyd.) Born et Flah. The author has come across such three-pored heterocysts in *Mastigocladus laminosus* Cohn., which is the second record of these interesting heterocysts.

Mastigocladus laminosus Cohn. exhibits a well-defined basal prostrate system and erect system of true branches arising from the basal system. Normally either in the basal system or in the branches an ordinary intercalary vegetative cell gets transformed into a double-pored heterocyst connecting the adjacent cells on either side.

In some cases, an intercalary cell of the prostrate system after giving rise to a branch, becomes converted into a heterocyst. Consequently such a heterocyst has three pores instead of two, connecting the three adjacent cells, *viz.*, the two adjacent cells in the prostrate system and the lowermost cell of the branch (Figs. 1-4). These three-pored heterocysts in all respects, are just like the ordinary single- or double-pored heterocysts. Sometimes, the lowermost cell of the branch also becomes converted into a double-pored heterocyst (Fig. 4).

These triple-pored heterocysts are but the necessary consequence of the transformation of the intercalary vegetative cell which is attached to the three adjacent cells. It may also be expected that many more of the blue-green algæ exhibiting true branching may have such three-pored heterocysts, to which, of course, no systematic or biological significance can be attached.



FIGS. 1–4

In conclusion, I am highly thankful to Dr. M. S. Randhawa for his keen interest and criticism during this investigation. My thanks are also due to Dr. B. P. Pal and Dr. S. M. Sikka for their great interest and for providing the facilities to carry out this work.

Botany Division, I.A.R.I., New Delhi-12, *May* 22, 1957.

G. S. VENKATARAMAN.

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ON THE OCCURRENCE OF *DICHOTOMOSIPHON* (A. Br.) ERNST. FROM INDORE (M.P.)

Dichotomosiphon (A. Br.) Ernst. is considered to be one of the rare fresh-water green algæ. Biswas[1] (1949) mentions that the genus has not been reported from India so far, but it seems that he has not referred to Randhawa's[2] (1942) paper in which records of its occurrence from Rajpur District of Allahabad and Pinahat District of Agra, have clearly been made. Besides these, however, there is no mention of its occurrence from any other part of India.

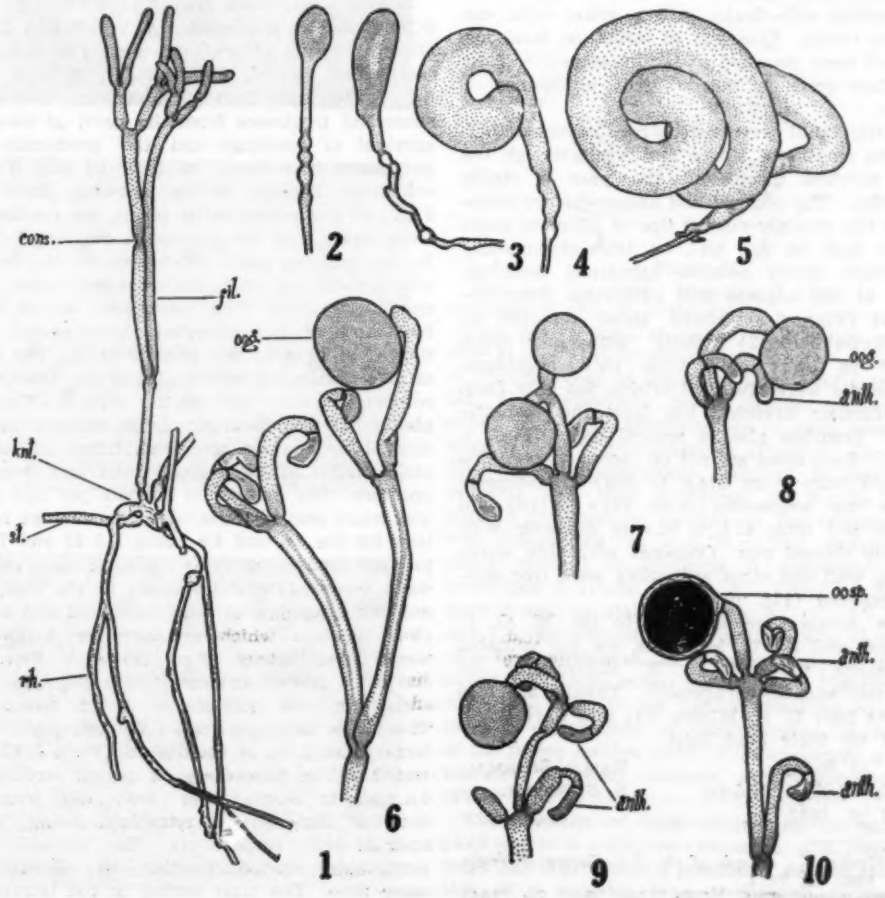
The authors have observed this alga growing abundantly in Indore and work on this is in progress. This note gives a preliminary report of its occurrence and some of the important features.

The alga is collected from a narrow, 3 ft. to 6 ft. wide channel, supplied by a lake, Peeplyapala, situated at a distance of 3 miles from the city. The stream is shallow, permanent and slow-running with high embarkments on both sides. The bed is formed of coarse gravel

covered with fine silt. The vegetation on the spot is mainly composed of *Equisetum debile, Canscora diffusa, Moniera cuneifolia* and *Cyperus rotundus*. Fertile material has also been collected near Sirpur tank on Dhar Road (Indore).

The alga is provisionally taken to be *D. tuberosus* Ernst., although differences in the shape of akinetes, position of antheridia and size of oogonia have been noted. The alga is chiefly confined to the thickly silty sides of the stream in the form of dark bluish-green cushions. Alongwith this is found in winter a species of *Batrachospermum* growing epiphytically on *Cyperus rotundus* and *Moniera cuneifolia*. The ultimate ends of the green branches of *Dichotomosiphon* are exposed out freely while the rhizoidal system, along with the major part of the thalli, remains embedded inside the silt, giving it a peculiar and characteristic appearance.

The filaments vary from 5 mm. to 35 mm. in length and 42 μ to 105 μ in diameter with the characteristic dichotomous branchings and constrictions at and between the dichotomies (Fig. 1). At the base of the green thalli, a



FIGS. 1–10. *Dichotomosiphon tuberosus* Ernst. FIG. 1. General structure of the plant body. Reconstructed, × 23. *fil.* = filament; *cons.* = constriction; *knt.* = basal knot; *st.* = stolon; *rh.* = rhizoid. FIGS. 2–5. Developmental stages of akinetes, × 35. FIGS. 6–9. Thalli showing different combinations of oogonia (*ogs.*) and antheridia (*anth.*), × 35. FIG. 10. Mature oospore (*oosp.*) and burst antheridia (*anth.*), ×35.

star-shaped brownish knot is formed, the arms of which extend into horizontal "stolons" giving rise to new knots and thalli. From these knots arise the downwardly growing rhizoidal threads which have lateral branchings with progressive decrease in diameter and with characteristic knee-like bends and knob-like swellings on them (Fig. 1).

Different stages in the development of akinetes were observed as shown in Figs. 2, 3, 4 & 5. These are formed at the tips of rhizoid-like green filaments arising from the dichotomy of the thallus. It originates as a swelling, gradually elongating into a club-shaped structure and then bending in the form of a sign of interrogation and finally into a spiral with one or two twists. This sort of structure, however, has not been reported so far by others.[3,4] They are dark-green in colour with abundance of starch.

Fertile thalli were extensively collected during the months of March and April, though the alga survives throughout the year in sterile condition. The oogonia and antheridia are formed at the strongly curved tips of ultimate thalli which may be di-, tri-, or tetra-chotomously branched. Every possible numerical combinations of the oogonia and antheridia were observed (Figs. 6-9) unlike those reported by Randhawa[2] (1942) where antheridia were found in pairs only with each oogonium. Antheridia were observed arising not only from the ultimate branches but from the "penultimate" branches also in several cases (Figs. 7, 9, 10). Such cases are not on record so far. The oogonia vary from 276 μ to 428 μ in diameter while the antheridia from 142 μ to 190 μ in length and from 47 μ to 85 μ in diameter with slightly dilated tips. Oospores with thin enveloping wall and burst antheridia were frequently observed (Fig. 10).

The authors are thankful to Dr. M. O. P. Iyengar and Dr. G. M. Smith for the valuable references, to Prof. D. W. Kshirasagar for facilities and encouragement. Thanks are also due to Shri D. N. Mishra Raj and Shri R. M. Patel for their kind help.

Dept. of Botany, Holkar College, Indore, *April* 26, 1957.

RAMJI SHARMA.
S. S. MOGHE.

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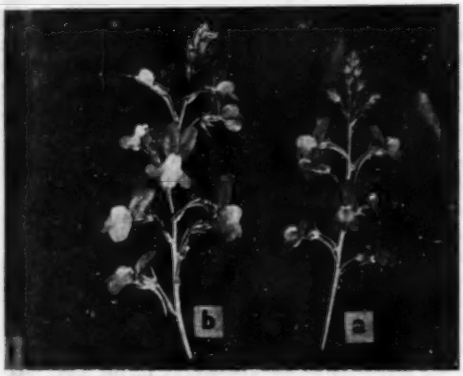
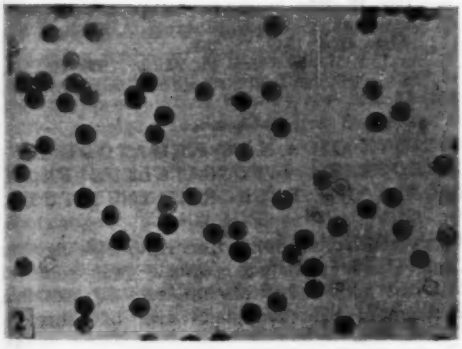
COLCHICINE INDUCED TETRAPLOIDY IN *LINARIA VULGARIS*

FROM the literature recently reviewed by Bali and Tandon,[1] it is seen that artificially induced polyploids in a number of ornamental plants have proved superior to their corresponding diploid progenitors. Work along this line was, therefore, started by the authors and a number of ornamental plants with small flowers and low chromosome numbers have been selected for this purpose. The present note deals with the work done on colchicine-induced tetraploidy in *Linaria vulgaris* which is a commonly grown winter ornamental.

Soaked seeds were dipped in 0·05, 0·10 and 0·20% colchicine solution for 3, 6, 9 and 12 hr. Growing points of seedlings with 4 to 6 leaves were also treated with 0·05, 0·10, 0·20 and 0·30% colchicine for 3, 6 and 9 hr. The most successful treatment from the point of view of survival of seedlings and the production of polyploids was found to be 0·10 and 0·20% colchicine applied to the growing point for 6 hr. In the seed-treated series, the cotyledons were thick and the hypocotyl region swollen. In the growing point treated series, the leaves which came out after the treatment were very small and thick. The subsequent leaves were like those of the untreated plants except that they were broader and slightly thick. The stem of the mature tetraploid plants was thicker in comparison with that of the diploid. The $4n$ plants had conspicuously large stomata as indicated by the measurements taken on length and breadth of their guard cells and stomatal aperture. The number of stomata per unit area was much less in tetraploids, the average numbers for the $2n$ and $4n$ being 115·82 and 72·43 per sq. mm. respectively. Similar observations were recorded with reference to the size and number of epidermal cells in diploid and tetraploid plants. The flowers borne on $4n$ plants were conspicuously large (Plate I, Figs. 1 *a* and *b*), a general enlargement in calyx, corolla, andœcium and gynœceum being noticeable. The fertile pollen grains of the tetraploid were larger than those of the diploid (Plate I, Figs. 2 and 3). The percentage of pollen fertility in $4n$ plants was rather low, the averages for the diploid and tetraploid being 93·45 and 38·84% respectively. The diploids and tetraploids started fruiting at almost the same time. The fruit setting in the tetraploids was poor. There was no difference between $2n$ and $4n$ fruits with reference to their size or shape. The average number of seeds per fruit in the diploid was 74·20. There was lot

of variation in the tetraploids with regard to the number of seeds per fruit. Although majority of the tetraploid fruits contained 50 to 55 well developed seeds per fruit, a few of them were either seedless or contained 3 to 5 seeds. The seeds of the tetraploids were larger than those collected from control plants.





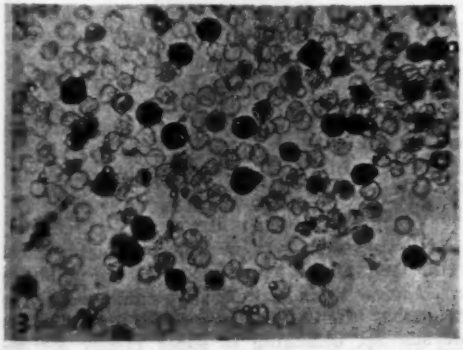


PLATE I

FIG. 1. Part of flowering shoot of diploid (*a*) and tetraploid (*b*).

FIG. 2. Pollen grains of diploid.

FIG. 3. Pollen grains of tetraploid.

All the colchicine-treated plants were cytologically analysed. Squashes of pollen mother cells were stained with acetocarmine. The diploids showed 6 bivalents at diakinesis and metaphase I (Plate II, Fig. 1). The distribution

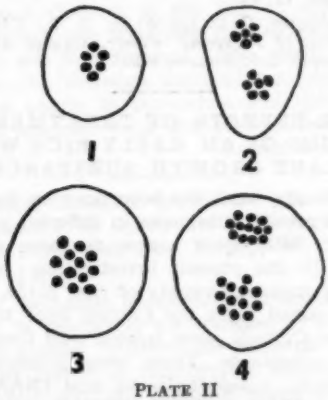


PLATE II

FIGS. 1–2. (× 900). Metaphase I (Fig. 1) and metaphase II (Fig. 2) in the diploid.

FIGS. 3–4 (× 900). Metaphase I (Fig. 3) and metaphase II (Fig. 4) in the tetraploid.

of chromosomes at anaphase I was quite regular, 6 chromosomes being clearly visible at either pole. Six chromosomes in each nucleus were noticed at metaphase II (Plate II, Fig. 2). The haploid chromosome number[2] in *Linaria vulgaris* was thus confirmed as $n = 6$. The haploid chromosome number in the tetraploids was determined as $n = 12$. The tetraploid plants showed 12 bivalents at diakinesis and metaphase I (Plate II, Fig. 3). Other configurations seen at diakinesis were 2^{IV} 8^{II} 1^{IV} 10^{II} and 6^{IV}. Majority of pollen mother cells showed $12 + 12$ distribution of chromosomes at anaphase I. In some pollen mother cells, 1 chromosome was seen to lag behind resulting in the unequal distribution of chromosomes. In most of the pollen mother cells, 12 chromosomes were included in each nucleus at metaphase II (Plate II, Fig. 4).

The presence of large flowers in the tetraploid plants is a desired character. The present work has thus shown a possibility for the selection of a superior type of *Linaria vulgaris*. It may be mentioned that the fruit and seed setting in the tetraploid plants was found to be rather low. This difficulty could, however, be overcome by leaving a larger number of plants for seed collection.

We are thankful to Prof. P. Maheshwari, Head of the Department of Botany, University of Delhi, for the facilities and encouragement.

Dept. of Botany, P. N. BALI.*
University of Delhi, S. L. TANDON.
Delhi-8, *July* 5, 1957.

* Lecturer in Botany, Hansraj College, Delhi 8.

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AFTER-EFFECTS OF TREATMENT OF GRAINS OF AN EARLY RICE WITH PLANT GROWTH SUBSTANCES

CONSIDERABLE work has been done on the effect of plant growth substances in different plants[1–7] but very little work has so far been done in rice.[8,9] In the present investigation, seeds of an early-maturing variety of rice, N.136, a pure line, obtained from the Central Rice Research Institute, Cuttack, were treated with three plant growth substances. These were β-indolylacetic acid (IAA), α-naphthylacetic acid (NAA) both auxins and 2, 3, 5-triiodobenzoic acid (TIBA), a so-called anti-auxin and three concentrations of 100, 250 and 500 p.p.m. were adopted. The seeds were soaked in the solutions for 72 hours. The treated seeds were sown in pots with six replications for each treatment and records were taken on resulting plants on days taken for ear-emergence as well as on morphological characters such as number of tillers, leaves and plant height.

With regard to ear-emergence, there was delay of about 4 to 7 days with NAA treatment, the maximum delay being with the highest concentration of 500 p.p.m. The other treatments produced no effect on ear-emergence.

Tillers, leaves and height of plants were on the average significantly reduced in the case of plants from NAA soaked grains. There was a gradual decrease in vegetative growth with increase in concentration of solution. There was a significant increase in the tiller and leaf formation in plants obtained from grains treated with 250 and 500 p.p.m. of the IAA and TIBA solutions. The variations obtained in the vegetative growth characters as a result of the treatments were more conspicuous at the younger stages and gradually disappeared with advancing age of the plant.

There were differences in grain yield of plants but these were not significant. Observations were taken on yield attributes such as number of panicles, length of panicle, number of grains per panicle, percentage of grain setting and 1,000 grain weight. There was significant increase due to treatment only in three cases; in number of panicle with IAA 500 p.p.m., in length of panicle and number of spikelets per panicle with NAA 500 p.p.m.

We are thankful to the Utkal University for award of the M. S. Gajapati Fellowship to one of us (G. S.), and to Prof. B. Samantarai for providing facilities in the Department of Botany, Ravanshaw College, Cuttack, for carrying out this investigation.

Dept. of Botany, G. MISRA.
Ravanshaw College, G. SAHU.
Cuttack-3, *July* 17, 1957.

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A NOTE ON A NEW NEMATODE ON *CHILOTRAEA INFUSCATELLUS* FROM SUGARCANE RESEARCH INSTITUTE, PUSA

WHILE conducting studies on *Apanteles flavipes* Cam, a new nematode parasite was recorded from the body cavity of *Chilotræa infuscatellus*, a common sugarcane stem-borer of Bihar.

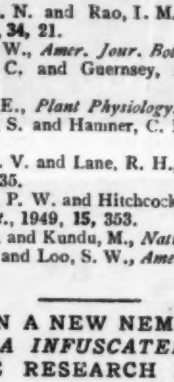

FIG. 1

The worm (Fig. 1) is almost straight, about 9 cm. long and 0·5 mm. wide. It is yellowish in colour and the cuticle shows fine transverse striations. This has now been identified as *Mermis* Sp. belonging to super family *Mermithoidea*.

Thanks are due to Dr. M. A. Basir Khan, Professor of Zoology, Aligarh University, for identification.

Sugarcane Res. Inst., S. MOHAMMAD ALI.
Pusa, Bihar, *June* 3, 1957.

REVIEWS

Gas Dynamics. By Klaus Oswatitsch. English version by G. Kuerti. (*Applied Mathematics and Mechanics Series*, Vol. I.) (Academic Press, New York), 1956. Pp. 610. Price $ 12.00.

The author is the Director of the Institute for Theoretical Gas Dynamics of the D.V.L. at Aachen and is well known for his contributions to the subject among which may be mentioned his work on supersonic diffusors and condensation phenomenon in high speed gas flows. The work under review is intended primarily to provide the foundations of modern gas dynamics. It does not aim to be an engineering handbook but while laying emphasis on physical reasoning and intuitive ideas so as to bring out essential interconnections it also contains surveys of advanced methods of analysis accompanied by tables and diagrams not generally found in text-books. The aeronautical engineer as well as the research scholar will find the presentation helpful and stimulating.

The general theorems of gas dynamics are formulated in a manner so that in most cases they refer to an arbitrary medium which is physically homogeneous, thus extending their applications. Examples have been worked out actually for the special case of a perfect gas with constant specific heat. Chapter I provides the thermodynamic basis for the treatment of gas flows. Chapters 2 and 3 deal with one-dimensional steady and unsteady motion and include flows with friction and heat addition. A discussion of the propagation of cylindrical and spherical waves in Chapter 3 covers some topics of common interest to gas dynamics and acoustics. Chapter 4 sets out the general theorem of mechanics of compressible fluids from an integral point of view so that shock phenomenon are included. In Chapter 5 some direct applications of the general equations are worked out. There is an interesting discussion of the paradox of a heated tube illustrating the author's stimulating and unconventional approach. Chapters 6, 7, 8 and 9 deal with general study in viscid flows, with particular solutions being discussed in detail. Chapter 10 deals with conical flow theory and applications to subsonic and supersonic finite wings. Chapter 11 briefly presents the foundations of compressible boundary layer theory and the effects of viscosity. Chapter 12 is a survey of experimental techniques and covers pressure and speed measurements, optical techniques, wind tunnels and wind tunnel measurements as well as gas dynamic analogies.

In the reviewer's opinion, Prof. Oswatitsch's book, while largely reflecting his own experiences and views is in the line of stimulating works which one associates with expositions by Prandtl and Von Karman. The clarity of exposition, the thorough account of fundamentals and the ability to interrelate and unify in a striking manner, these are evident throughout.

SATISH DHAWAN.

Momentum Transfer in Fluids. By WM. H. Corcoran, J. B. Opfell and B. H. Sage. (Academic Press, Inc., New York), 1956. Pp. 394. Price $ 9.00.

Fluid mechanics is becoming increasingly important to practically all branches of engineering and science. It forms the bed-rock of aerodynamics and is of considerable importance to mechanical, civil and chemical engineering. The book under review presents an account of a portion of this field dealing with fluid motions in which transport phenomenon are of primary importance. It is written by chemical engineers primarily for the chemical engineering profession. However, the point of view adopted in the presentation is general enough to make the book of wider value. The mathematical portions are sufficiently elementary and the scope sufficiently comprehensive to render the material valuable to the graduate student, teacher, research worker as well as the practising engineer.

After the introductory opening chapter, covering definitions, follows a concise presentation in Chapters 2, 3 and 4 of the basic principles of momentum transfer including the classical cases of flow in pipes and channels. Turbulent flow being predominantly encountered in technical applications these chapters review the basic knowledge about turbulent fluid motion. A major part of the material presented is already available in fluid mechanics literature. Nevertheless the incorporation of newer experimental information and the bringing together of widely scattered theoretical and experimental material amply justifies these chapters. Chapter 5 is devoted to a discussion of the general equations of fluid motion. Evidently this chapter is intended for the reader

without a background in fluid mechanics. A simplified derivation of the Navier-Stokes equation is given and application to Poiseulle flow and a few other cases worked in examples. A section on Reynolds' transformation of the basic equation of fluid motion for application to turbulent motions is also included.

Chapter 6 gives a sketchy but interesting account of some turbulence phenomenon. Concepts of correlation functions and spectral analysis are briefly discussed in relation to the quantitative description of turbulence. The section on turbulent eddy viscosity is particularly interesting as the authors discuss some new experimental data obtained by them in channel flows. Useful tables are given which permit the viscosity in conduits to be estimated. Chapter 7 is concerned with boundary layer motion. The Blasius flat plate solution, boundary layer on a circular cylinder (with a table for calculation), the Pohlhausen technique for flows with pressure gradient, mass removal/addition, etc., are some of the main topics covered. A short account of compressibility effects is also included. An omission in this chapter is three-dimensional boundary layers. A short account of the Mangler transformation would have added value. The brief section on transition is very incomplete and seems to leave the reader with an erroneous idea of the mechanism of transition. In recent years the theoretical work of Emmons and the experiments of Schubauer and Klebanoff and others have shown that the transition from laminar to turbulent motion is characterised by the random appearance of turbulent 'spots' and intermittent alternations of laminar and turbulent flow are fundamental to the mechanics of transition. An useful introduction to tensors and their application in the description of turbulence is given in an *Appendix*.

A feature of the book is the examples worked out in detail at the end of each chapter. The examples are few in number but are well chosen and illustrate admirably the application of the basic theoretical and experimental information discussed in the book.

SATISH DHAWAN.

Atomic Structure and the Strength of Metals. By N. F. Mott. (Pergamon Press, London and New York), 1956. Pp. ii + 64. Price 15 *sh.*

This book comprises the three Page-Barbour lectures delivered by the distinguished author at the University of Virginia in October 1956. Primarily meant for University students of humanities, these lectures deal in easily comprehensible terms with the results of some recent researches which have contributed at long last to an understanding of the familiar mechanical properties of metals. Phenomena like the hardening of metals on alloying, bending or hammering were known to smiths before the days of written history, but have only recently been explained as due to the existence of imperfections known as "dislocations" in the atomic arrangement of the metals. The rapid development of the theory of dislocations and the recent experimental evidence for their presence in metals have been dealt with in these lectures with admirable lucidity. Although rather expensive, this book is bound to be read with interest not only by students of humanities, but also by students of physics and metallurgy.

T. R. ANANTHARAMAN.

Relaxation Methods in Theoretical Physics, Vol. II. By R. V. Southwell. (Clarendon Press, Oxford), 1956. Pp. vi + 372. Price 55 *sh.* net.

The present volume is a continuation of the author's earlier treatises *Relaxation Methods in Engineering Science* and *Relaxation Methods in Theoretical Physics*, Vol. I. The book is mostly a compilation of the work carried out by Professor Southwell and his school. It presumes a knowledge of the relaxation method of which an account is given in the earlier volumes and deals with the application of the method to boundary value problems that figure in several branches of Applied Mathematics and Engineering.

In all the problems of which the book deals with, the application of the relaxation method to the solution of differential equations with boundary conditions is carried through four distinct steps which may briefly be stated as follows: Firstly, the problem is transformed into a numerical one by the introduction of a set of new variables which render the governing equation non-dimensional. Secondly, derivatives are replaced by expressions in finite differences so that continuous space gets approximated by a set of discrete lattice points or a network of them. Next, the well-known procedures of 'relaxation' and 'liquidation' characteristic of the method are carried out to such a network and the final solution of the problem is represented either by contour lines or by numbers at the nodal points of a graph sheet.

The book starts with Chapter VI. This and the next chapter are devoted to a discussion of the biharmonic equation $\nabla^4 \omega = Z(x, y)$. After

a brief recapitulation of the technique of the relaxation method and an account of the finite difference approximation to $\nabla^4 \omega$, the author discusses a number of two-dimensional problems like the motion of viscous fluid through a nozzle, the flexure of elastic plates, stresses in a cement 'briquette' and so on which have both academic as well as practical interest. The solution in all the cases are represented by diagrams which are self-explanatory.

Chapters IX and X relate to an extension of the standard relaxation method, in which two nets are used simultaneously to compute two wanted functions of the independent variables. This replaces a single biharmonic pattern applied to determine a single function by two simpler patterns used to determine two functions simultaneously and has the merit of reducing the computational labour considerably. A large class of problems dealing with axially symmetric strain in complete solids of revolution which are of practical interest to the engineer are discussed under this heading.

Chapter XI takes a turn to dynamic problems and the author discusses the normal free vibrations of stretched membranes and of electrodynamic systems. Whereas the physical configuration of static systems under a given set of external forces and conditions are obtainable by minimising a single function — the potential energy, in vibratory problems the quantity to be minimised is the ratio V/T of two functions, namely, of the potential and kinetic energies of the system. But for this modification in the variational principle, the relaxational technique to be employed under such cases remains the same. The chapter contains an useful account of Kato's theorem concerning the lower bounds of the eigen values.

The rest of the book deals with non-linear problems which are gaining ever-growing importance in Applied Mathematics, and with some attempts to extend the range of the relaxation technique to differential equations involving three independent variables. Chapter XIII contains a derivation of von-Karman's equations for largely deflected plates and a few of its applications. In Chapter XIV, two interesting examples are discussed, namely, high-speed flow of viscous fluid past a fixed cylinder and plastic straining in two-dimensional stress systems, and the relaxational solutions obtained for these are illustrated by a large number of diagrams.

The range and variety of examples included in the book illustrate the power of the relaxational technique in solving boundary value problems of different types and of varying degrees of complication. The reviewer would however prefer to take exception to the outlook of the book towards analytical procedures which the author chooses to call as 'orthodox methods'. Several approximate methods like the perturbation method, the variation-iteration method, the hyper-circle method and so on, are available at present to solve boundary value problems and these analytical procedures have a beauty, intellectual charm and generality of their own which make them fascinating to one and all. Perhaps the value of the relaxation method lies most in its practical utility to the engineer confronted with boundary conditions and surfaces that are not expressible in precise mathematical language.

The book is written with the same clarity of exposition and lucidity of style that is characteristic of Professor Southwell's classic work on elasticity. Coming from the originator of the method and containing as it does a wealth of material that are available only in current periodicals, the book will prove to be valuable to all workers in the field and others wishing to get acquainted with this subject.

K. S. VISWANATHAN.

The Geometry of Geodesics—Mathematics Monograph, Vol. 6. By Herbert Busemann. (Academic Press, Inc.), 1955. Pp. vii + 422. Price $9.00.

The book is an extension of the methods developed earlier by the author in his book, *Metric Methods in Finsler Spaces and in the Foundations of Geometry*, published in 1942. The treatment is exhaustive and self-contained. Some of the proofs given in this book are more elegant than those given in the earlier book. It deals with the global geometry of geodesics, which have been assumed to have only local uniqueness properties, and with the Finsler spaces in particular. The book has been divided into six chapters, *viz.*, the basic concepts, Desarguesian spaces, perpendiculars and parallels, covering spaces, the influence of the sign of the curvature on the geodesics, and homogeneous spaces. Most of the work is the outcome of the authors' own researches. At the end of the book, a number of problems solved and unsolved has been listed and some theorems have also been given, which indicate further possible developments of the theory of Finsler spaces. The bibliography is exhaustive. This book of the distinguished author will be a valuable addition to the libraries of all workers interested in the subject. RAM BEHARI.

Earthquakes in the Himalayan Region. By Dr. S. K. Banerji. (Indian Association for the Cultivation of Science, Jadavpur, Calcutta.) Pp. 64. Plates VI. Price Rs. 3.

The present monograph deals with the incidence, causation and genesis of earthquakes in the North Indian region. Few earthquakes have visited the Deccan region south of the Vindhya Mountains, but the number of destructive earthquakes that have shaken the plains of the Indo-Ganges valleys and the mountain ranges to their north number no less than 73 during the last two centuries. This part of North India falls within the great seismic belt which traverses the earth equatorially from east to west and is a zone of geological weakness and strain, implied by the severe crumpling of the crust in the Himalayas, within geologically very recent times, and which has therefore not yet attained stability or quiescence. The author, who has had considerable experience of seismic phenomena in India, as Director-General of Meteorological Department, treats the subject of Himalayan earthquakes largely from the physical background, their mechanism, causation, genesis from shallow or deep foci (the deep-foci earthquakes of the Pamir-Hindukush and the Assam-Burma regions have depth of focus ranging from 100 km. to 250 km.), the energy released by quakes of high intensity (in some cases equivalent to that released by some 100 *megaton* bombs). There is an obvious relation between the regional distribution and frequency of occurrence of earthquakes and the areas of excess or defects of gravity in the Himalayan region and the plains at their foot. There are brief notes on the weight of the Himalayas and their support at the roots, on suggested hypotheses regarding the causes of earthquakes, such as isostatic compensation, the theory of thermal contraction of the earth's diameter, movement of crustal blocks, on Wegener's hypotheses and the strains involved in the mountain-building forces in the crust. Within a compass of 60 pages, the author has treated these and touched upon other related problems, such as gravity anomalies, the mechanism of shallow focus and deep focus earthquakes, the aftershocks attending the two types.

To students of Indian geology, the erection of the Himalayan chain from underneath the waters of an ancient Mediterranean Sea is much the most significant event of earth history and he will find much of interest in the discussion of the abovementioned physical and geophysical problems. As the author has clearly shown, earthquakes in the Himalayan region raise far-reaching questions of distribution of underground gravity, isostatic equilibrium between the elevated region and the sunken plains, tracts, as well as the plastic flow of subcrustal magma to bring about gravity adjustment between the two.

Seismic phenomena in the Himalayas have evoked prolonged studies by several distinguished scientists of the Geodetic Survey of India and there is an extensive literature on the subject of orogeny of the Himalayas, their age, duration, phases of uplift, the post-glacial uplift and subsequent adjustments by faulting and dislocation. The author has given copious references to this stock of information, while discussing their findings. These discussions, however, suffer from too much brevity and condensation.

Dr. S. K. Banerji and the Indian Association for Cultivation of Science are to be thanked for their presenting this handy monograph on an important subject. D. N. W.

Industrial Rectifying Tubes, Vol. XIII. By Members of Philips Electron Tube Division, Philips Technical Library. (Distributors for India: Philips Electrical Co., Ltd., 7, Justice Chandra Madhab Road, Calcutta-20), 1957. Pp. 126 with 100 illustrations and 182 tables. Price Rs. 8-12-0.

Several periodicals and books of scientific and technical interest have appeared from the Philips Technical Library publications and these have undoubtedly proved to be of assistance to designers of electronic instruments for scientific and industrial applications. Of these, particular mention may be made of a series of twelve volumes on electronic tubes that have appeared from time to time. These contain technical data for Philips tubes and ample circuitory to be of help to those who employ Philips electronic components.

The book under review is the XIIIth of the series and deals with the operation of Philips hot cathode gas-filled rectifying tubes used in battery chargers, industrial power rectifiers, cinema rectifiers and D.C. arc welders. Such tubes are called upon to deliver large currents at relatively low voltages. The gas-filled tubes with their low internal resistance are best suited for these applications, as they have a high current capacity and efficiency. The efficient operation of a rectifier installation depends on the choice of suitable type of tube and proper design of the associated circuit. These consi-

derations are fully dealt with in the present book.

A brief account of the general characteristics of the hot cathode gas-filled rectifying tubes is given in the first few pages. The next section describes battery charges operated from single as well as polyphase mains supply with resistors or chokes as their current limiting devices. Design considerations of mains transformers and current limiting devices are explained in relation to the output currents and voltages. Simple formulæ and tables are given for the calculation of component values. The section on industrial rectifiers deal with rectifying tubes of higher output for feeding industrial equipment, such as electromagnets, electromagnetic chucks and separators, D.C. motors and power station auxiliaries. Full-wave and half-wave rectifiers operating with, and without power transformers on single and polyphase mains are described. Anode impedance calculations and their design for rectifiers operating directly from the mains are given. The autotransformer method is also explained. In the next two sections, rectifiers for operating arc lamps for cine-projection, and welding rectifiers of high current output are described.

Diagrams of all the basic circuits ordinarily encountered in the abovementioned applications are given and several actual examples are worked out. Quite a number of tables and graphs are included which will be of help in the design of rectifier circuits. Further, technical tube data for eighteen Philips rectifier tubes are given with diagrams and base connections. Philips auxiliary equipments such as ignition units, bimetal relay and baretters for rectifier systems are described. Finally a selection chart which greatly facilitates the choice of the circuits and types of tubes is attached. The book will be of special interest to practical designers of rectifying circuits for varied industrial applications.

A. JAYARAMAN.

Micro-Chemical Journal, Vol. I. Issue 1. (Interscience Publishers, New York and London), 1957. Pp. 166. Subscription $ 9.60 per year.

A special feature of twentieth century chemistry is the emphasis placed on micro-methods. If the second quarter of the century saw the rise and the spread of microchemical technique, the third quarter is witnessing the development of ultra-micro technique. Originally Austria was the home of microchemistry and 'Mikrochemie' was the Journal. As in the case of many other scientific subjects, the U.S.A. is taking the lead here also and since the new 'Micro-Chemical Journal' will be in English, it can directly serve a large number of workers. It is an effort on the part of the Metropolitan Microchemical Society to obtain a wide distribution of the philosophy, ideas and techniques of microchemical procedure as applied to all areas of the physical and biological sciences.

The Journal will be semi-annual and the first issue contains a number of interesting papers covering a large range of topics including electrochemical, microscopic, thermomicro and colorimetric methods and also instrumentation. It includes a small history of the Metropolitan Microchemical Society. The final part of the Journal contains abstracts of articles relating to microchemical investigations (January 1955 to July 1956). Beginning with the next issue, it will include: (1) letters to the editor, (2) reviews of books on subjects related to microchemistry, and (3) new instruments, methods and techniques.

One could foresee a great future for this new Journal. The subscription rate is quite high but it could partly be justified because (i) it is a specialised Journal, (2) it contains a large number of illustrations, and (3) the printing and get-up are of high order.

T. R. SESHADRI.

The Water Relations of Terrestrial Arthropods. By E. B. Edney. (Cambridge University Press), 1957. Pp. vi + 108. Price 15 *sh.*

The physiological importance of the water economy of terrestrial arthropods especially those of small size is well known, but it is only recently that investigations on the mechanism of water balance have been attempted. In the volume under review the author has given a comprehensive account of the problems associated with the water economy of these animals, such as water loss from the integument, respiratory surfaces and through excretion, the means by which such loss is regulated, the mechanism of water uptake including absorption of water vapour, internal regulation of water and electrolytes and the role of metabolic water. In this context a critical assessment of work bearing on the subject has been given and the main trends of advancement indicated. It is clear that the data accumulated so far is not as complete as may be desired and much more experimental work remains to be done before a generalization can be arrived at. In this connection the importance of the study of the cuticle must be emphasized, for it is

through the cuticle that transport of water both outwards and inwards is regulated and such regulation is intimately associated with the structure and properties of the cuticle. The author has discussed at some length the role of the wax layer of the cuticle in relation to its impermeability to water and as a means of conserving the water resources of the animal. It has also been observed that in some arthropods there takes place an exchange between body water and external water while in others the animal is able to absorb water vapour from the atmosphere. Such observations suggest a selective permeability of the cuticle and an investigation of the means by which this is achieved involves more intensive study of the histochemistry of the cuticle. There is need for correlating histochemical studies on the cuticle with experimental observations on the water relations of the animal. But it must be pointed out that so far the progress made in the study of the structure and chemistry of the cuticle has not kept pace with the physiological advances in this line. It is surprising that the author's references to work on the chemistry of the cuticle are not exhaustive and some recent work on the cuticle of arthropods, other than the insects, has been ignored. However, the author by bringing within the compass of a comparatively small volume, recent work bearing on the water economy of terrestrial anthropods, has served to focus attention on an important but hitherto less known aspect of arthropod physiology. This work is a valuable addition to the literature on arthropods and should prove useful to research workers and students of advanced zoology.

G. KRISHNAN.

The Early Embryology of *Pyrilla perpusilla* Walker (Homoptera) including Some Observations on the Later Development. By Klaus Sander, Ph.D. (Alig.), Monograph IV. *Aligarh Muslim University Publications* (Zoological Series). *On Indian Insect Types.* Edited and Published by Professor M. B. Mirza. (Printers: Baptist Mission Press, Calcutta), 1956. Pp. 61. 12 Plates. Price Rs. 5.

The monograph under review is one of a series of publications of the Department of Zoology of the Aligarh Muslim University on "Indian Insect Types", of which three monographs have already appeared, *viz.*, (1) "External and Internal Anatomy of the Buffalo Louse", by Qadri; (2) "Biology, Life-History and External and Internal Anatomy of *Pyrilla perpusilla* Wlk.", by Qadri and Aziz; and (3) "The Skeleto-Muscular Mechanism of *Stenobracon deesæ*", Parts I and II, by Mashhood Alam. The present publication is by Klaus Sander, Ph.D. (Alig.), Fellow, Indo-German Industrial Co-operation Scheme (October 1952 to April 1955), who took up the study of the early embryology of the Sugarcane Pyrilla at Aligarh with the aid of a Fellowship granted by the Government of India.

In an earlier publication, Qadri and Aziz had studied the biology and anatomy of this bug, but had not investigated its embryonic development, and this was undertaken by Sander, presumably at the suggestion of Prof. Mirza, and was carried out in the course of a period of over two years. A perusal of the account given by the author in the monograph under review would show that he has apparently made a thorough job of it. The report runs into 61 pages of text and 12 plates containing 59 figures and the observations recorded cover all phases of development from fertilisation to the formation of the main organs of the insect: maturation of the germ-cells; fertilisation; early cleavage of the germ plasma; the formation of the blastoderm and the yolk-cell membrane. At the end of 24 hours, there is an invagination of the germ-band, leading to the formation of the embryonal layers and the development of the various systems of the organism. At this stage (at the end of about 72 hours), an evagination occurs, whereby the embryo frees itself of the yolk-membrane cover. One of the main features of the *Pyrilla* egg is the inclusion of rudiments of the mycetom in its interior, composed of cells of three types of symbiont organisms, presumably derived from the symbiont cells of the mother.

The results of the embryological studies made have been succinctly presented in the summary given at the end.

An exhaustive list of the literature consulted has been given.

The monograph maintains its usual attractive form and the printing is excellent, with practically no printing errors. Y. R. RAO.

Books Received

An Introduction to Reactor Physics, Vol. I, Div. X. By D. J. Littler and J. F. Raffle. (Pergamon Press, Ltd., London, W.1), 1957. Pp. x + 208. Price £ 1-10-0.

Quantum Chemistry—An Introduction. By Walter Kauzmann. (Academic Press Inc.; Asia Publishing House, Bombay), 1957. Pp. xii + 744. Price $ 12.00.

Advances in Protein Chemistry, Vol. XI. Edited by M. L. Anson, K. Bailey and J. T. Edsall. (Academic Press, Inc.; Asia Publishing House, Bombay), 1956. Pp. x + 665. Price $12.00.

Applied Mathematics and Mechanics, Vol. II. (*Jets, Wakes and Cavities.*) By G. Birkhoff and E. H. Zarantonello. (Academic Press, Inc.; Asia Publishing House, Bombay), 1957. Pp. xii + 353. Price $10.00.

Mercury and Its Compounds. Edited by Otto V. St. Whitelock. (*Annals of the N.Y.A. Sciences*, Vol. 66, Art. 5.) Pp. 357-652. Price $3.50.

Second Tissue Homatransplantation Conference. Edited by Otto V. St. Whitelock. (*Annals of the N.Y.A. Sciences*, Vol. 64, Art. 5.) Pp. 735-1073. Price $4.50.

Chromatography. By E. and M. Lederer. (Cleaver-Hume Press, Ltd., 31, Wrights Lane, London W.8), 1957. Pp. xx + 711. Price 72 *sh.*

Technique of Organic Chemistry—Fundamentals of Chromatography, Vol. X. By Harold Gomes Cassidy. (Interscience Publishers, Inc.), 1957. Pp. xvii + 447. Price $9.75.

Methods of Biochemical Analysis, Vol. IV. Edited by David Glick. (Interscience Publishers, Inc.), 1957. Pp. ix + 362. Price $8.50.

The Pharmacology of Psychotominetic and Psychotherapeutic Drugs. By Otto V. St. Whitelock. (*Annals of the N.Y.A. Sciences*, Vol. 66, Art. 3, 2, East 63rd Street, New York-21), 1957. Pp. 417-840. Price $5.00.

Cambridge Monographs in Experimental Biology—Parthenogenesis and Polyploidy in Mammalian Development. By R. A. Beatty. (Cambridge University Press, London N.W.1), 1957. Pp. xi + 131. Price 15 *sh.*

Proceedings of the Zoological Society. By J. L. Bhaduri, B. Biswas and S. P. Roy Chaudhuri. (The Zoological Society, 35, Ballygunge Circular Road, Calcutta-19), 1957. Pp. vi + 396. Price Rs. 30.

British Medical Bulletin—The Liver: Some Physiological and Clinical Aspects, Vol. 13, No. 2. (Medical Department, The British Council, 65, Davies Street, London W.1.) (India: Oxford University Press), May 1957. Price 20 *sh.*

Anesthesiology and Its Problems. Edited by Otto V. St. Whitelock. (*Annals of the N.Y.A. Sciences*, Vol. 66, Art. 4.) Pp. 841-1022. Price $4.00.

Microscope—Construction, Use and Care. By Y. K. Sane. (Published by the Author, Ganeshwadi, Baroda), 1957. Pp. 24. Price 50 nP.

SCIENCE NOTES AND NEWS

New Technique in Radar

A significant improvement in radar has been announced by the Columbia University.

The new techniques do not increase the power used but, instead, employ a method of signal enhancement which raises the strength of a radar signal reflected from an aircraft "to an unprecedented high level". The equipment consists of a radar transmitter which generates a carefully controlled system and a receiver which enhances the echo system received from an aircraft, according to the announcement.

Combination Electron Microscope and X-ray Analyser

A device was recently exhibited by U.S. Steel which combines the features of an electron microscope and X-ray diffraction analysis. The electron microscope unit focussed a beam of electrons on a spot no more than two microns in diameter. The recording X-ray analyser was then able to give a chemical analysis of the material at the spot on which the electrons impinged.

With the device it was possible to show the alloy composition of individual crystals in a metallurgical surface. Other data on display indicated the use of the device in showing the degree and rate of penetration of one metal into another, *e.g.*, a copper deposit on a steel base. Some apparently very accurate graphs were shown indicating the depth of penetration of the one metal into the other after different times and the temperatures of annealing and with different crystalline forms of iron.

Radiometer for Prospecting Uranium

Soviet engineers have all but completed the development of a light and cheap radiometer

for prospecting uranium deposits. It is a version of the aerographic station known as the ASG-38 and extensively used for prospecting uranium.

The 'heart' of the station consists of sodium iodide crystals activated by thalium. It reacts to the presence of uranium or thorium ores, while an amplitude discriminator determines the radioactive element discovered by the prospecting plane.

The ASG-38 has been tested in different regions of the U.S.S.R. and has proved its high dependability. Already the first prospecting glights with the ASG-38 station have resulted in the discovery of industrial deposits of uranium ore.

"Hypalon," A New Elastomer

The Du Pont Laboratories at Wilmington, U.S.A., brought out a few years ago a new type of synthetic rubber which they named Hypalon. It is reported that since then the material has been distributed for test purposes and that it is gaining widespread acceptance. Like neoprene, hypalon was created with a specific quality in mind, in this particular case, the resistance of the material to attacks by oxygen, ozone and heat. Other valuable qualities of the new material to which attention is drawn are its ease of formulation and its ability to hold colours varying from pastels to deep shades. A circular recently issued contains details regarding the resistance of hypalon to sunlight and chemical attack as also its ability to stand up to high temperatures. Data are furnished regarding its tensile strength, its electrical properties and its flexibility for various compositions. The characteristic properties of hypalon indicate that in the coating field its applications will be of primary importance.

Second World Metallurgical Congress

The above Congress sponsored by the American Society for Metals will be held in Chicago, Illinois, U.S.A., from 2nd to 8th November 1957.

About 500 metal scientists from 36 different nations are expected to take part in the Congress. A two-week tour, starting in mid-October in New York City and terminating in Chicago, has been arranged by the Society so that the scientists attending the Congress might inspect many of the major metal working plants of the country and study their working carefully and discuss the confronting problems at the Congress with each other.

It is estimated that about 50,000 American industrial leaders will attend the world gathering when various sessions of the Thirty-Ninth National Metals Exposition and Congress will be held simultaneously and in conjunction with the World Congress.

Further information regarding the Congress can be had of: The American Society of Metals, 7,301, Euclid Avenue, Cleveland-3, Ohio, U.S.A.

World Forestry Congress in 1960

It has been decided to hold the Fifth World Forestry Congress in the United States in 1960 in the State of Washington or in Oregon. The Pacific Northwest is outstanding for its great forest wealth, complex and variety of forest industries, national forests, research centers, forest schools and other forest institutions. The regional tours and field excursions to be arranged will provide an unparalleled opportunity to observe at first hand the advance of technological development that have taken place in the United States in recent years. The meetings will be of individuals rather than of government representatives. The responsibility for the technical and financial arrangements has been accepted by the host country.

The Canadian Journal of Chemical Engineering

By agreement between the National Research Council and the Chemical Institute of Canada, *The Canadian Journal of Technology* has been taken over by the Chemical Institute and now appears in a new format under the title, *The Canadian Journal of Chemical Engineering*. The issue for June 1957, is the first number of the new Journal. It will be published every second month. Subscription rates are $3.00 per year; U.K. and U.S. $4.00; Foreign $4.50. Single copies can be had at 75 cents each. These are to be addressed to the Chemical Institute of Canada, 18, Rideau Street, Ottawa-2, Ontario.

Award of Research Degrees

The Andhra University has awarded the D.Sc. Degree in Physics to Shri K. Subba Rao for his thesis entitled, "Ultrasonic Studies in Solid and Liquid Media by New Methods", and the D.Sc. Degree in Chemistry to Shri B. V. Sreeramachandramurty for his thesis entitled, "Some Aspects of Vandametry".

The University of Poona has awarded the Ph.D. Degree in Chemistry to Shri K. G. Divekar for his thesis entitled, "Spectrophotometric Studies of Ferric Phenol Complexes".

Dr. K. Venkataraman

Dr. K. Venkataraman, Director, Department of Chemical Technology, Bombay University, has been appointed Director, National Chemical Laboratory, Poona, from August 1, 1957.

746-57. Printed at The Bangalore Press, Bangalore City, by C. Vasudeva Rao, Superintendent and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

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